EMBARGOED

FOR RELEASE ON
WEDNESDAY,
APRIL 8, 1987

SDI: PROGRESS AND CHALLENGES
PART TWO

Staff Report Submitted To

Senator William Proxmire and Senator J. Bennett Johnston

March 19, 1987

By:
Douglas C. Waller
James T. Bruce

EXECUTIVE SUMMARY

One year ago, the authors of this report produced a study assessing the progress made in Strategic Defense Initiative research and the challenges that lay ahead for the program. That study, titled SDI: Progress and Challenges, concluded that while progress had been made in the program no tremendous breakthroughs had been achieved to warrant a conclusion at this time that comprehensive strategic defenses were feasible. Furthermore, the study detailed significant problems strategic defenses faced, such as satellite survivability, discrimination of warheads from decoys, and space transportation and logistics.

An updated study was requested by Senator William Proxmire and Senator J. Bennett Johnston to again examine the progress SDI has made since the release of the last study. Furthermore, this report was tasked with analyzing the current movement within the Administration to commit this country to a so-called "near-term" deployment of strategic defenses and to assess the considerable reorientation the SDI program has recently undergone as a result of this movement.

The authors interviewed more than 60 SDI scientists, engineers, project managers, and ballistic missile defense experts for this report. Extensive briefings were held at the nation's three national weapons laboratories conducting SDI research, the Air Force Space Division, and with key defense contractors involved in SDI work.

The findings of this study are:

• If the President publicly announces a decision to commit to a near-term deployment of strategic defense as some have urged, no SDI weapons system is ready for deployment today. There is nothing to deploy today.

• The Strategic Defense Initiative Organization (SDIO) is reorienting its program to pursue vigorously a near-term deployment of ballistic missile defenses, possibly in the 1994-95 timeframe. This reorientation is not awaiting a publicly announced Presidential decision to commit to near-term deployment. The President's FY1987 budget, FY1987 supplemental request and FY1988 budget request for SDI would implement that reorientation toward the near term.

a. The program's directed energy weapons (DEW) budget has been drastically cut while the kinetic energy weapons budget is enjoying a healthy increase. The DEW program is researching technologies for a far-term defense, while the KEW program has a heavy concentration of near-term technologies.

b. In a number of instances, far-term innovative SDI technologies are being scaled back to pay for the near-term option.

c. In the ground-based interceptor projects, SDI has cut back on the advanced technology development while the early technology demonstrations of these interceptors is being

heavily funded. The early demonstrations will not produce militarily capable systems; only the far-term research will accomplish that. This appears to be an example of SDI being more interested in the near-term demonstration of a weapon than in developing a militarily capable weapon in the far term.

d. SDI has scaled back research into space-based sensors that would be used for discrimination and tracking of warheads in the midcourse phase. Effective midcourse discrimination was always considered to be unavailable until near the end of the century.

e. SDI has significantly reoriented its spaced-based kinetic kill vehicle (SBKKV) project to pursue a near-term deployment in the mid 1990's instead of the late 1990's. Under orders from SDIO, the project is now pursuing a SBKKV system of much more limited capability than that previously discussed as essential for SDI boost-phase defensive systems.

f. To place the SBKKV system and other sensor satellites in space in the near-term SDI is rushing development of a heavy-lift launch vehicle. Last year, space transportation was not as high a priority for SDI as developing the exotic technologies that would be deployed in the far term. But with the push for a near-term deployment, the SDI space transportation budget has been drastically increased and a hurry-up schedule for building a heavy-lift vehicle is being put into place. This push for early production of a heavy-lift launch vehicle creates a risk of significant distortions in the U.S. military and civilian space programs.

• We have been told that SDIO has a "black program" that is developing a reference architecture for a near-term deployment of strategic defenses -- that is, a highly classified program which is developing a blueprint for deploying strategic defenses in the near term. Access to this near-term architecture program is compartmentalized so that only a few members of Congress would be allowed to review it if they knew it existed. In fact, it appears that most members of Congress are being kept in the dark about this secret program. While SDI has been telling members of Congress and their staffs that no such near-term architecture exists, it appears that SDI officials have been quietly approaching their contractors to draw up plans for a near-term deployment.

• Based on careful review of the reorientation that is under way within the SDI program and the tasks assigned to contractors, the authors believe that the near-term deployment SDIO has in mind for the 1994-95 timeframe would have an effectiveness against Soviet ballistic missile warheads of no more than 16%. Such a deployment in 1994-95 would have:

a. no laser or beam weapons, as are popularly associated with SDI;

b. a token deployment of space-based kinetic kill vehicles in the boost phase that would likely be able to destroy no more than 11% of the Soviet offensive threat;

c. no midcourse kill or discrimination capability to speak of; and

d. 400-1,000 ground-based interceptors, produced on a hurry-up schedule, that might destroy no more than 5% of the incoming warheads.

• Many assume that a near-term deployment could be easily accomplished. They are seriously mistaken. A review of the technologies being considered for near-term deployment revealed that they face tremendous engineering and production problems that will require a sizeable amount of research talent and substantial funding increases to overcome.

• A near-term deployment of space-based kinetic kill vehicles would have limited military utility in space of perhaps 5 to 10 years as the Soviets responded with countermeasures, including proliferation of offensive forces. SDI scientists envision a variety of possible Soviet countermeasures and, in fact, do not agree on which countermeasures the Soviets would deploy. They do agree, however, that the Soviets would deploy countermeasures and it would not be too long before the initial fleet of U.S. kinetic kill vehicles in space, if not augmented with other systems, would be rendered largely ineffective and interceptors on the ground would be swamped by warheads and decoys.

• SDI scientists are deeply concerned that critical far-term strategic defense research will be sacrificed to pay for the huge cost of a near-term deployment. If the U.S. proceeds with a near-term deployment, said one scientist, "you can't expect to maintain a robust research program. There will be a big tendency to move ahead by eating your children." There is evidence that the program already is siphoning off funds from the far-term technology research efforts to pay for increased emphasis on the near term.

• If the U.S. proceeds with a near-term deployment, the Soviets can develop countermeasures to overcome that deployment, SDI scientists agreed — the only question is when the Soviets can overcome the initial defense. That is why it is critical that if the U.S. deploys in the near term it also has the follow-on, more exotic laser and beam technologies ready to defeat the anticipated Soviet countermeasures. If that follow-on technology is not available as the near-term defense degrades, "you may well end up with a more destabilizing situation than before," said one SDI scientist. At this point, however, SDI does not know whether the follow-on technologies would be available at the appropriate time. Even if they were, it is unclear whether there will be enough money to support a near-term deployment and to pursue the follow-on technologies.

• Last year, the authors reported that there had been progress made in the SDI program, but that there were no amazing

breakthroughs to settle the question of whether comprehensive strategic defenses were feasible. This year, the authors note that significant progress again has been made in the SDI program. But again, based on the author's interviews with SDI scientists and engineers, there have been no tremendous breakthroughs. More importantly, the progress made in the program the past year does not appear to serve as a compelling justification for a near-term deployment.

CONCLUSIONS

As a result of the extensive briefings and interviews conducted during the past two months, this report comes to the following conclusions:

1. In the past, Congress has appropriated a topline funding figure for the Strategic Defense Initiative and avoided specifying how that money should be allocated within the program. Congress has not wanted to "micromanage" the SDI program and has therefore allowed the SDI Director wide latitude to allocate funds within SDI and determine its priorities. Congress, however, may want to reexamine this policy in light of the considerable reorientation that is going on within SDI toward a near-term deployment. Congress should not assume that this reorientation awaits a public announcement of Presidential approval. It is already under way.

2. Members of Congress should inquire if a "black" program has been set up to develop a near-term deployment architecture and, if so, why such a high classification level is required. As one scientist and an SDI contractor pointed out to us, the program is being kept in the black largely because it is too immature at the moment to stand the test of rigid scrutiny. SDI, nevertheless, should not be allowed to pursue a program that has such political and diplomatic ramifications without broad Congressional review.

3. Congress should be skeptical of claims that a near-term deployment could be easily accomplished. Our review of the technical and production hurdles involved with a near-term deployment indicate they are substantial and would require significant scientific resources and large funding increases. Congress has had a long acquaintance with military programs that run into problems during production and deployment, despite the most optimistic predictions and best intentions. Congress, therefore, should assume that a near-term deployment would not avoid the same production delay and cost overrun problems most military programs often face.

4. A near-term deployment in the 1994-95 timeframe, because of its very limited capability, would not significantly enhance U.S. national security and would only serve somewhat as a complicating factor for Soviet attack plans. Congress should examine carefully whether such a deployment is worth (a) the significant costs that would be incurred, (b) the likely destruction of the 1972 ABM Treaty, and (c) the likely deep division it will cause between the U.S. and its allies.

5. Since its inception, SDI every year has undergone radical shifts in its priorities. Every year for the past three, SDI officials have come to Congress asking for hundreds of millions of dollars targeted at what they claimed were critical priorities, only to change those priorities the next year. Moreover, these fluctuations are more the result of decisions made by SDI's own managers rather than congressional budget cuts. Congress should heed the warning of SDI's own scientists who say that what the program

desperately needs is stability.

6. Congress should not let another year pass with SDI still refusing to provide cost estimates (not cost goals) for strategic defenses. In particular, Congress should be wary of any near-term deployment option that does not come with realistic cost estimates. Moreover, Congress should ensure that no deployment in the near or far term be made unless it is cost effective at the margin and survivable, per the requirements of current law.

7. A near-term deployment would involve sizeable federal expenditures for (a) the near-term deployment itself and (b) the follow-on technologies that would have to be ready when the near-term deployment capability degrades. Congress must decide early on whether it is willing to commit such large sums of money to both the near-term and the follow-on deployments. Once we start the race, there will be no turning back. Deploying near-term defenses without following up with the far-term technologies would produce highly destabilizing results. In light of the funding caps placed on SDI in years past, Congress must ask itself whether it is prepared to make this leap in spending.

8. Congress should raise more questions about what happens with the second move. In other words, what happens after the U.S. launches a near-term deployment. How long will it take the Soviets to respond? Will follow-on technologies be able to counter this response? Will there be a national commitment to devote considerable resources to these follow-on technologies? We were struck with how much uncertainty there is among SDI scientists and engineers about what would happen in the second move.

9. For the past two years, senior SDI and Administration officials have claimed tremendous breakthroughs in the SDI program, which demonstrated that strategic defenses were feasible. A close examination of these claims invariably reveals that while the program has made progress in numerous areas, the progress pales in comparison to the technical hurdles that remain toward achieving a militarily capable system. Congress, therefore, should be just as wary this year of inflated claims of success as it was last year. This year, moreover, senior SDI and Administration officials argue that breakthroughs in the program justify, and indeed compel, the movement toward a near-term deployment. We could find little scientific evidence to substantiate these claims, based on our interviews with SDI scientists and engineers. Politics -- not technology — is behind the movement toward a near-term deployment.

Congress, therefore, may wish to consider four important questions this year:

• Should the SDI program be reoriented to pursue vigorously a near-term deployment of strategic defenses?

• What are the implications for SDI research overall and for U.S. national security if such a reorientation proceeds?

• What are the federal expenditures and strategic uncertainties if Congress decides to accede to the first step of a near-term deployment?

• Does the progress made so far in the SDI program really justify leaping into a near-term deployment?

I. SCOPE OF THE REPORT

One year ago, you directed us to assemble an in-depth report on the Strategic Defense Initiative. At the time, senior Administration and Department of Defense officials had stated that SDI had made tremendous strides and "incredible" breakthroughs the previous two years. On March 17, 1986, we submitted to you a report detailing the progress that had been made in the SDI program and the challenges that lay ahead. The report also outlined a number of changing priorities within the program as it pursued the President's vision of a nearly leakproof shield against Soviet offensive nuclear weapons.

Because the SDI program appears to have undergone considerable reorientation since our submission of the 1986 report, you directed us to compile a second report to assess these changes and their implications. In particular, high Administration officials and some of SDI's more avid proponents have been pressing the President to commit this country to a so-called "near-term deployment" of ballistic missile defenses that would significantly change the nature of SDI research and necessitate U.S. withdrawal from or abrogation of the 1972 ABM Treaty.

This study, "SDI: Progress and Challenges Part Two," was therefore initiated to review the current work SDI is performing, particularly that which may be related to a near-term deployment, and to assess its implication for the program's overall research goals and for U.S. national security. In all, more than 60 SDI managers, scientists, engineers, industry representatives and ballistic missile defense experts were interviewed for this study.

We began by receiving extensive briefings from SDI's top managers in charge of the Sensors, Directed Energy Weapons, Kinetic Energy Weapons, Battle Management/C^3, and Support programs. We next visited the following facilities conducting SDI research:

- Los Alamos National Laboratory, Los Alamos, New Mexico. Los Alamos is conducting extensive research into various directed energy concepts, including neutral particle beam weapons or interactive discriminators, and the Radio Frequency (RF) Linac Free Electron Laser. We also received briefings from experts at Los Alamos's Center for National Security Studies, which is investigating the national security implications of strategic defenses.

- Sandia National Laboratory, Albuquerque, New Mexico. Sandia is conducting research into various directed energy concepts, space power, threat analysis, Soviet countermeasures, space survivability and systems concepts.

- Lawrence Livermore National Laboratory, Livermore, California. Livermore is conducting research into a number of directed energy weapons concepts, including the Induction Linac Free Electron Laser and the X-ray laser. Livermore also has been involved in threat analysis and architecture work for an SDI system.

- U.S. Air Force Space Division, Los Angeles, California. One of five

divisions of the Air Force Space Command, the Space Division executes the service's research into SDI, particularly as it relates to boost, post-boost and midcourse defenses. We were briefed on the Space Division's work on space-based kinetic kill vehicles (SBKKV), boost surveillance and tracking system (BSTS), space surveillance and tracking system (SSTS), and the heavy-lift launch vehicle (HLLV).

• Hughes Aircraft Company, Los Angeles, California. Hughes is involved in practically every aspect of SDI research and development. We were briefed by officials from Hughes's Space and Communications Group and Missile Systems Group on the company's work on high endoatmospheric interceptors (HEDI) and space-based kinetic kill vehicles (SBKKV).

• Lockheed Missile and Space Company, Sunnyvale, California. We were briefed on Lockheed's work on the space surveillance and tracking system (SSTS) and the exoatmospheric reentry vehicle interceptor subsystem (ERIS).

In addition to the above visits, we received briefings from ballistic missile defense experts from the Army's Strategic Defense Command, the Stanford University Center for International Security and Arms Control, the Johns Hopkins Foreign Policy Institute, the Institute for Defense Analyses, the Congressional Research Service, and the General Accounting Office. We also interviewed privately other contractors and scientists involved in SDI research.

As was the case with the 1986 study, this year's report is not meant to be a comprehensive assessment of SDI research. Rather, it attempts to highlight key issues with respect to SDI that Congress may want to consider.

II. BACKGROUND

On March 23, 1983, in a nationally televised speech, President Reagan announced he was launching what would become the largest military research program the United States had ever undertaken — a massive scientific effort to render nuclear weapons "impotent and obsolete." Out of this vision of a nuclear weapons free world, there quickly evolved the Strategic Defense Initiative, whose charter from the Department of Defense directed it to research defenses against nuclear ballistic missiles only.

Defense against a just-as-potent air-breathing nuclear threat — from bombers and cruise missiles — was to be researched under a separate program, the Air Defense Initiative, which is being funded at a much lower level than SDI. The nuclear threat from unconventional delivery mechanisms — i.e. terrorist attacks or smuggling weapons into the United States — is being ignored for the moment.

Following the President's March 1983, the Defensive Technology Study Team, or Fletcher Panel as it came to be known, was formed to lay out a blueprint for a long-term research program to achieve a comprehensive ballistic missile defense system. Some have called this system an "astrodome shield" to protect the United States from incoming Soviet ballistic missiles.

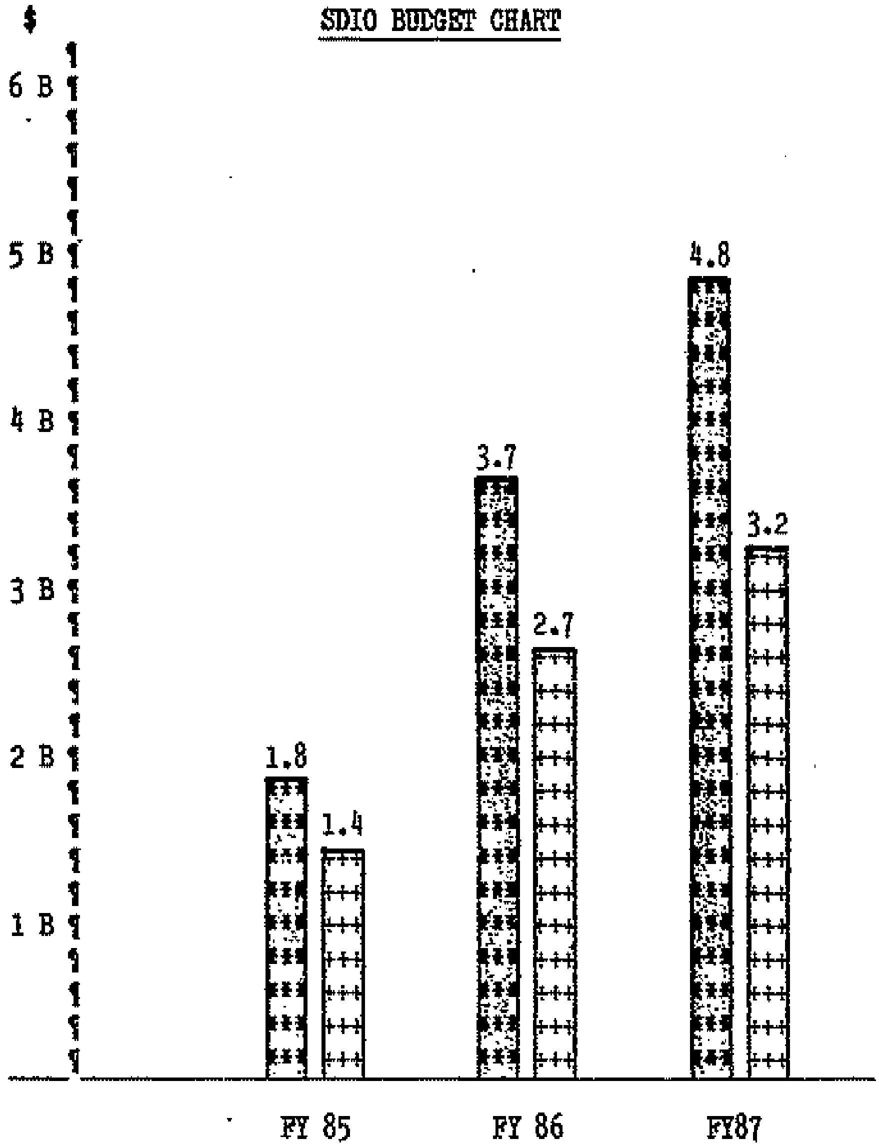
The Fletcher Panel's report presented two types of strategic defense research programs that might be pursued. One was a funding-limited program, in which the pace of the research is limited by the funds Congress appropriates. In the other approach, a technology-limited program which the panel recommended be pursued, the pace of research is limited only by technological progress. In essence, money is no object.

The Strategic Defense Initiative Organization (SDIO) has submitted technology-limited budgets to the Congress for fiscal years 1985, 1986, and 1987. Congress, however, has in effect approved funding-limited budgets for those years. (See Figure 1 for a comparison of the Administration's request for the fiscal years and Congress's appropriation. It shows the funding for the DoD portion of SDI only.) In FY1985 the Administration requested $1.78 billion for SDI, a 79% nominal increase over the previous year's funding level. Congress approved $1.40 billion for FY85, a 41% increase. In FY1986, the Administration requested $3.72 billion for SDI, a 166% increase over FY85. Congress approved $2.76 billion, a 97% increase. And in FY1987, the Administration requested $4.8 billion for SDI, a 74% increase. Congress approved $3.2 billion, a 16% increase.

Clearly Congress has allowed a huge funding increase for U.S. research into strategic defenses. The SDI program's budget has more than tripled since its inception, it has become the largest military research program in DoD — the department's top strategic priority — and its funding level now surpasses the combined technology base funding for the Army, Navy and Air Force. But just as clearly, Congress has approved largely funding-limited budgets for SDI. There has been broad bipartisan support in Congress for a robust ballistic

Figure 1

SDIO BUDGET CHART



KEY

= ADMINISTRATION REQUEST

= CONGRESSIONAL APPROPRIATION

missile defense research program funded at much higher levels than in years past. But there has been little Congressional support for a technology-limited research effort — or "crash program" as it has been more aptly called.

Furthermore, in 1986 Congress clearly signaled its intent to allow only moderate SDI funding increases in the future. The 16% increase approved by the Senate for FY87 survived being cut further by just one vote. The House approved by a significant margin a freeze on SDI spending at the FY86 level. Moreover, the Senate approved language from its Armed Services Committee expressing deep concern over the complex and uncertain nature of comprehensive strategic defenses and directing that the research be refocused toward more manageable and realistic objectives.

Around the time the FY87 DoD Appropriations Bill passed Congress in the fall of 1986, and shortly after the failed Reagan-Gorbachev summit in Reykjavik, Iceland, a small group of SDI's more ardent supporters within the Administration, in the Congress, and in private institutions began pressing publicly for a "near-term" deployment of strategic defenses. Press reports indicated a deepening concern among these supporters that the SDI program was losing political momentum because its research objectives were too far in the future to compel large funding increases in the present. That slippage, it was feared, would continue unless the program produced something identifiable — such as strategic defense hardware — that Congress and the American could rally around.

This concern was perhaps best articulated in an October 1, 1986, letter to President Reagan signed by some of SDI's strongest supporters: Rep. Jack Kemp, Rep. Jim Courter, Sen. Rudy Boschwitz, Eugene V. Rostow, Dr. Edward Teller and Dr. Lowell Wood. That letter which called for "employment in the very near term of the most modern defensive means" stated further:

"We are deeply concerned that a SDI program which has no definite consequences for defense of America within the next ten years will not be politically sustainable ... We believe that imperfect but significant defensive options have already been laid before the American leadership by the SDI, and that they must not only be continued toward perfection but also prudently exercised, while the political will to do so undeniably exists."

Political motivations are likely not the only reason for SDI proponents advocating a near-term deployment of strategic defenses. In fact, an SDI scientist who briefed us at the Livermore National Laboratory listed four possible reasons near-term advocates might have for rushing to deploy whatever SDI research could produce in the near term:

1. <u>To cement the program politically.</u> Changing SDI from a military research program to a military construction program would undoubtedly produce greater constituent pressure for high spending levels, particularly from states and Congressional Districts where the hardware would be built. Moreover, Members could see some tangible

result for the billions of dollars they had appropriated.

2. To develop early experience in an operational ABM system. This would mirror somewhat the Soviet approach. While the Soviet ABM system ringing Moscow is crude by U.S. technology standards and considered ineffective against a U.S. strategic blow, the system does give Russian troops operational training on working hardware.

3. To force a decision in the current Administration on the so-called "broad" interpretation of the ABM Treaty. The Administration in 1985 unilaterally announced a reinterpretation of the ABM Treaty, concluding that — contrary to previous findings of this Administration — the accord did allow testing and development of strategic defense weapons based in space. The program the Administration has proposed for SDI would eventually require not only this broad interpretation of the treaty, but also its eventual abrogation or U.S. withdrawal from the accord. The feeling among near-term deployment advocates might be that it is better to force now the initial decision on the broad interpretation, rather than wait for another Administration to face that choice.

4. Because the U.S.-Soviet military balance and U.S. national security compel the United States to begin a near-term deployment. For example, the above letter by Rep. Kemp et.al. expresses concern over the absence of U.S. strategic defenses against what it claims is "the growing Soviet ballistic threat (which) imperils the entire Western Alliance." In other words U.S. national security has seriously deteriorated recently thereby compelling this country to commence a near-term deployment.

None of the reasons listed above can be credited singly with being the motivation behind the near-term push. Perhaps some combination of these reasons can be attributed to near-term advocates. Asked which reason compels those within the Administration to push for near-term deployment, our Livermore briefer, who has been closely involved in SDI's systems architecture work, said he felt it was No. 3 -- to force an early decision on the broad interpretation of the ABM Treaty. The briefer added, "it's definitely not No. 4" -- because U.S. national security is seriously imperiled. Indeed, in the extensive interviews we conducted for this study, we found no credible evidence to suggest that U.S. national security considerations compelled a move toward near-term deployment at this time.

(Some near-term deployment advocates have also claimed that they were compelled to that position by language in last year's Senate Armed Services Committee Report on the FY1987 Department of Defense Authorization Bill. They maintain that the Committee report endorsed a near-term deployment and urged SDI to move in that direction. The committee report did not say that, however. What the report said was that "a portion of the SDI research program should emphasize options for near-term deployment as a hedge against the possibility of a Soviet ABM 'breakout' in the near term." The report goes on to state that "SDI should be dedicated to developing survivable and cost effective defensive options for enhancing the survivability of U.S. retaliatory forces and command, control and communications." In other

words, the report calls for researching near-term options that might serve as a cost-effective and survivable hedge <u>in case</u> the Soviets break out of the ABM Treaty. The report specifically does not call for deploying near-term defenses no matter what the Soviets do, as is advocated by near-term proponents.)

Whatever the ultimate reason for the near-term push, high Administration officials have been publicly advocating it and pressuring the President to give his formal approval to such a move. Secretary of Defense Caspar Weinberger appears to have taken a lead role in this effort. On January 12, 1987, before the Senate Armed Services Committee, Mr. Weinberger testified that it is "quite possible" that part of SDI will be deployed when it is ready rather than waiting for the full system to be perfected. Ten days later, in a Colorado Springs speech, Mr. Weinberger stated, "Today, we may be nearing the day when decisions about deployment of the first phase can be made. We are now seeing opportunities for earlier deployment of the first phase of strategic defense than we previously thought possible ... our bags are packed."

On January 14, 1987, Attorney General Edwin Meese III said the Administration should quickly deploy the first stage of SDI "so it will be in place and not tampered with by future administrations."

During the past two months, there have been a number of reports and intense speculation in the press over an imminent Presidential decision to put a near-term deployment into motion. So far, no such decision has been publicly announced, and depending on the Administration source -- be it pro or anti-near term -- it is unclear at this point from the public record how close the President is to making such a decision. Furthermore, little information has been made public as to what a near-term deployment would look like or what it would take to launch such an effort.

Several advocates outside the Administration have offered up their visions of a near-term deployment (see Figure 2). Most of these visions, however, have been accompanied by only skimpy amounts of empirical data or analysis, if at all.

Last October, the Heritage Foundation proposed deploying 100 upgraded missile interceptors over five years, projecting its cost to be $3.5 billion. Such a deployment presumably would be ABM Treaty compliant, but would have only token effectiveness, against perhaps a stray Soviet ICBM missile. (The United States could not be completely protected against an errant submarine-launched ballistic missile, because of its particular flight path.) Interestingly enough, officials at Lockheed, which has the ERIS missile interceptor contract, briefed us extensively on their idea for a 100-interceptor missile deployment, which would cost the same as the Heritage proposal.

Also last October, High Frontier, a grass-roots Star Wars organization, proposed a "ground up" near-term deployment consisting of ERIS interceptors and space-based kinetic kill vehicles. The system supposedly would take up to seven-and-one-half years to deploy

UNCLASSIFIED

Figure 2

PROPOSALS FOR EARLY DEPLOYMENT

HERITAGE FOUNDATION (Oct. 1986)
- Terminal and Midcourse Defense
- Upgraded Patriot, ERIS
- Initial deployment within 5 years
- Cost estimate: $3.5 bil. for 100 ERIS and upgraded radars/sensors

HIGH FRONTIER (Oct. 1986)
- Terminal, Midcourse, and Post-Boost Defense
- All KEW: cloud guns, ERIS, SBKKV
- "Ground up" deployment taking 3, 5 and 7.5 years
- Cost estimate: $2.6 bil.+ $3 bil.+ $10-25 bil.

GEORGE C. MARSHALL INSTITUTE (Dec. 1986)
- Terminal, Midcourse and Post-Boost Defense
- All KEW: HEDI, ERIS, SBKKV
- 7 years from decision to full deployment
- $54 bil. for IOC, $121 bil. for FOC

Source: Congressional Research Service

UNCLASSIFIED

and cost as much as $30 billion.

In December 1986, the newly formed George C. Marshall Institute issued a near-term deployment report, which it claimed was drawn from an "up-to-date data base" provided by SDI's program managers. The Marshall Institute report claimed that for $121 billion the U.S. could begin deploying within seven years 11,000 space-based interceptors and 13,000 ground-based interceptors. DoD and SDI officials have told us privately that the Marshall Institute deployment cost projections are unrealistic and based on highly inflated estimates of U.S. capabilities. In fact, near-term advocates within SDI have complained to us that hyped predictions, like the Marshall Institute's, have damaged the credibility of their own claims for such a deployment.

Later sections of this report will detail SDIO's efforts to move toward a near-term deployment and offer a glimpse of what that deployment might look like. For the moment, however, it would be helpful to put the near-term deployment option into perspective — particularly as that option relates to the original research goals of the SDI program. In doing so, it is best to start with DoD's charter formally establishing the Strategic Defense Initiative on April 24, 1984.

The charter instructs SDI to "undertake a comprehensive program to develop key technologies associated with concepts for defense against ballistic missiles." In other words, SDI was directed to be a military research program, with the ultimate goal of eliminating the threat posed by nuclear ballistic missiles.

It was envisioned by SDI that its research phase would last at least into the earlier 1990's and perhaps stretch into the mid-90's depending on the funding picture. Deployment was projected to begin, in phases, beginning in the late 1990's. For the moment, however, SDI's tasking has been to conduct military research into the President's ultimate objective.

Nowhere in SDI's charter is the program directed to prepare for a near-term deployment. The only mention of that subject comes in one sentence: "The program <u>shall protect U.S. options</u> (emphasis added) for near-term deployment of limited ballistic missile defenses."

In the years following, Administration and SDI officials have insisted time and again that SDI is just a research program. The 1985 SDI Report to Congress stated, for example, that SDI seeks "to exploit emerging technologies" associated with concepts for defense against ballistic missiles. The 1986 Report to Congress stated the same objective.

In other words, the SDI program is pursuing research on a broad and varied number of paths with no set weapons systems in mind as yet. The program's intention has been to pursue every relevant technology to its fullest, to establish milestones for these technologies, but to have a decision come later on which technologies would be translated into actual weapons systems. Lt. Gen. James Abrahamson, SDIO director, has used the term "horserace" to describe the SDI concept of

research. Traditional military programs, on the other hand, start not only with a fixed goal in mind — to develop a particular weapon — but also with an ultimate objective — the actual weapon. (A comparison of these two concepts is depicted in Figure 3.)

What the near-term deployment advocates are pressing the President to do in effect is bring, at an early stage, all the disparate points of the SDI concepts depicted on the right-hand side of Figure 3 to one single point. In other words stop the race, and gather in the horses.

Administration officials, in the past, have resisted bringing the SDI research program prematurely to a definite end point. They have resisted defining beyond generalities what such a defense system will look like, insisting that was why the SDI research program was established — to answer those questions. Moreover, Administration officials in the past have resisted any premature deployment of SDI, as damaging to the overall goals of the program. On August 6, 1986, President Reagan himself made this point to a group of SDI supporters:

> I know there are those who are getting a bit antsy, but to deploy systems of limited effectiveness now would divert limited funds and delay our main research. It could well erode support for the program before it's permitted to reach its potential.

As will become evident later from the facts uncovered in this study, the President's statement last year may have been more prescient than he realized at the time.

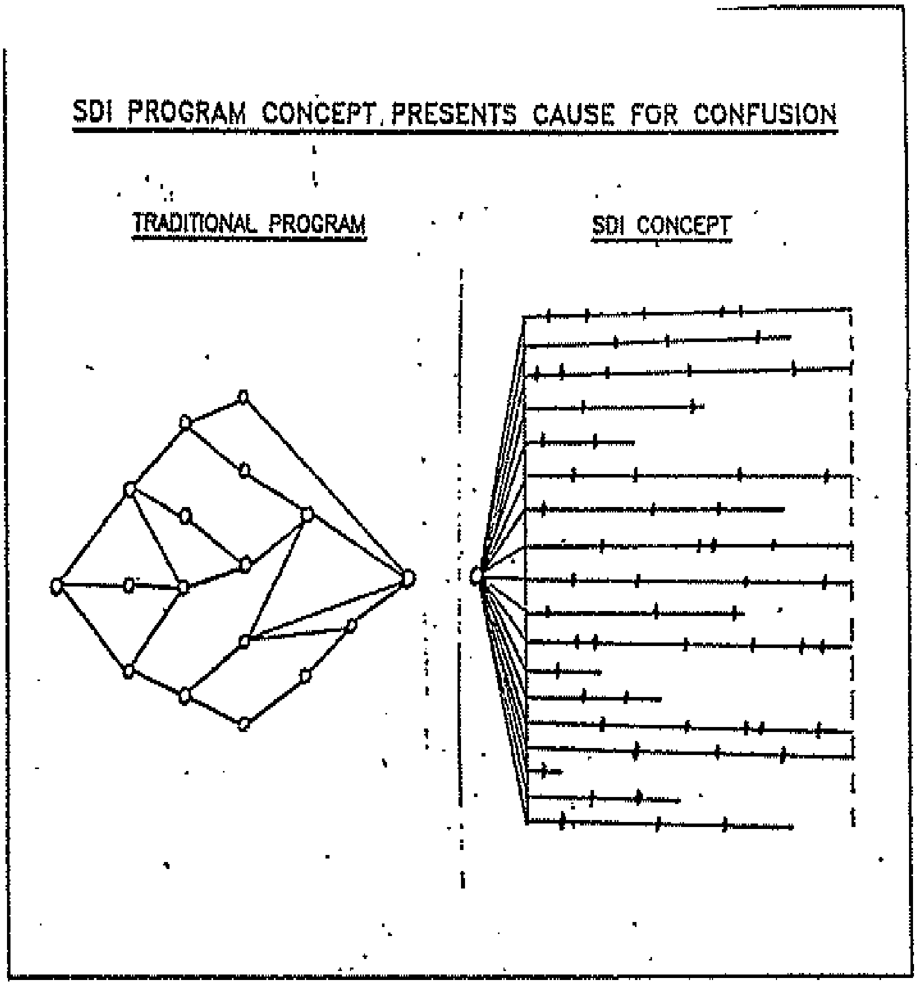
As noted before, little public information has heretofore surfaced as to what Administration officials have in mind when they speak of a near term deployment. However, Secretary Weinberger has stated clearly two things he does not want a near-term deployment to end up being.

First, Mr. Weinberger has stated at a number of public forums, such as his Colorado Springs speech, that a near-term deployment "would <u>not</u> (his emphasis) be a point defense, as some have urged, to protect missile fields." In other words, any near-term deployment would be a partial area defense — or as he has stated "an integral first phase of our whole tiered defense."

Second, Mr. Weinberger has categorically rejected deploying off-the-shelf technologies now, as has been advocated by the High Frontier organization. His deputy, William H. Taft IV, repeated that insistence at a February 3, 1987, hearing before the Senate's Defense Appropriations Subcommittee. In other words, Mr. Weinberger is not interested in deploying crude devices now that might protect missile silos, for example. Rather, he favors deploying early only those sophisticated devices that would be part of the larger, far-term area defense.

As he stated in his Colorado Springs speech, "An early deployment of defensive components that protected only some military assets and

Figure 3



Source: Congressional Research Service

was not part of a global defense, would weaken our SDI program and rob us of limited resources. Phase one, whatever form it takes, must be one piece of the entire system that provides a thoroughly reliable defense for the free world."

III. UPDATE FROM LAST YEAR'S REPORT

In the March 1?, 1986, report we recounted how the Administration claimed "amazing breakthroughs" and "incredible" progress in SDI research. Based on interviews and briefings with scientists last year, we concluded that, in fact, SDI research had not advanced so dramatically that the question of the technical feasibility of comprehensive strategic defenses had been settled. While there was progress, to be sure, we saw no evidence of tremendous breakthroughs or amazing leaps of technology.

A major point of last year's report was recognition of the magnitude of the undertaking to convert exotic laser and beam technology into usable devices in a strategic defense. Even last year many of these exotic technologies were little more than concepts, about which the physics were not fully understood. Of course, the potential payoff of these exotic technologies — for the U.S. or U.S.S.R. — would be significant. Any strategic defense that operates in the boost or midcourse phases must contend with vast distances between the defense and its target. And it must track and intercept thousands of objects moving at extreme velocities of about 15,000 miles per hour. Thus the advantage of weapons whose lethal beam can travel at or near the speed of light is obvious.

This year, Administration officials continue to claim "dramatic results" with SDI, although now the claims are made not so much about exotic technology research but rather about the not-so-exotic rocket technologies, which compared to directed energy weapons are easier to develop. In referring to these conventional technologies, Secretary Weinberger on January 22, 1987, said, for example:

> Some elements of our research have proved successful beyond the expectations of the most optimistic scientists and engineers. In fact, our research has progressed so well that we now have an unprecedented degree of confidence in the feasibility of defense against Soviet missiles — for ourselves and our allies. Let me give you a couple of examples of how far we have come in recent months. The first is the result of our Delta-180 experiments.

A. Delta 180

The Delta-180 experiment, which Mr. Weinberger claimed produced "remarkable results," investigated space intercept for kinetic kill vehicles. "We put together functionally the components that would represent a space intercept of an object being boosted out of the atmosphere," Mr. Weinberger explained. "This experiment was so successful that it established firmly the principle that a moving target can be hit with a kinetic weapon from space."

Indeed, the Delta-180 experiment collected a great deal of valuable data for SDIO. But it was hardly a major breakthrough in the technology. A prime objective of the test was to acquire close-up data on what rocket plumes look like in space. Early computer simulations have shown the difficulty of locating a rocket amid the

expanding plume of hot gases it emits while travelling in space. The degree of difficulty depends on the viewing angle. The second and third stages of the orbiting Delta rocket were equipped with sensors to observe the plumes emitted from the two stages' liquid rocket motors. The sensors also observed the plume from a solid-fueled Aries rocket that was launched separately from the ground.

At one point in the experiment, the second and third stages of the Delta rocket were aimed at each other. Their rocket motors were ignited and the two stages collided at high speeds, simulating a kinetic kill. This part of the experiment also afforded closer examination of rockets and their plumes.

The guidance for the stage simulating a kill vehicle was accomplished with an off-the-shelf Phoenix missile radar system. Incidentally, the simulated kill vehicle's homing was helped along by a radar reflector that was placed on the target vehicle. The fact that the two stages collided in this carefully controlled experiment should not be construed as a major breakthrough for developing a space-based kinetic kill vehicle system.

In fact, Lt.Gen. Abrahamson indicated that SDIO had attempted in Delta-180 to simulate not the kinetic kill vehicle, but rather the upper stage of a missile, which would be a typical target to a defense system and which would provide data on rocket plumes. "I think you have to understand right from the beginning that this is an experiment," the general said. "This is not a demonstration of some kind of capability for a space-based kinetic kill vehicle." A follow-on experiment called Delta-181 is planned to collect additional data.

B. Progress in SDI Research

Based on our interviews with SDI managers, scientists, engineers, industry representatives, and ballistic missile defense experts, we conclude that there has been considerable progress made in the program the past year. Some of that progress is quite impressive.

For example, the

according the Livermore briefers. As currently envisioned, the X-ray laser would be ground- or sea-based and launched by rocket into space in the event of a Soviet attack. A nuclear bomb on the rocket would detonate in space and just before being vaporized, the laser would convert a small percentage of the extraordinary energy of the nuclear explosion into intense beams of X-rays aimed at multiple targets.

Progress on the neutral particle beam accelerator is also impressive. The first use of this device would be as an interactive discriminator to sort out decoys from warheads. At higher power levels the neutral particle beam could serve as a potent weapon in space. The critical problem is reducing the device's weight for space use. Sandia scientists also reported a "breakthrough" last year when a radio frequency quadrapole was adapted to provide a high quality ion beam for the accelerator.

The free electron laser was prominently featured in last year's far-term architectures. The free electron laser has a number of advantages over other lasers, which will be discussed later in this report. However, converting the free electron laser concept into a weapon is not just a matter of engineering ingenuity. SDI scientists are still trying to understand the physics involved in this concept, especially at higher power levels. The scientists caution that the free electron laser still faces several key physics experiments in the coming years. The laser's ability to scale up to high power levels has still not been established, as has the question of whether a ground-based FEL can be propagated through the atmosphere. SDI research into FELs at low power levels, however, has been promising.

In summary, while no "show stoppers" have apparently surfaced with the FEL program, SDI scientists are still trying to understand the physics of the problem. Once they are understood, building a high-powered, battle-capable laser would still face major technological and engineering hurdles. Furthermore, while the FEL may one day prove to be a feasible weapon — most likely in the 21st century — SDI scientists at this point do not know whether it will.

C. Boost Phase Survivability

Last year's report emphasized that the boost-phase intercept is the linchpin in a successful strategic defense. A Soviet booster rocket is relatively easy to detect and track because of its huge infrared signature. Because each missile may carry 10 MIRVed warheads plus hundreds of decoys the ideal opportunity to attack the Soviets' strategic nuclear force is in the boost phase. Figure 4 shows how the Soviet force might be thinned out by the boost phase.

The importance of the boost phase was also repeatedly underscored in this year's briefings. As one scientist put it, "If you want a robust system, you have to be able to deal with the boost phase, or one hell of a lot will get through."

Any boost-phase defense, however, must have key elements based in space, even if they are only sensors or relay mirrors. Last year's report described why survivability is the ultimate problem any space-based system faces. A sampling of the Soviet countermeasures that might degrade survivability include anti-satellite (ASAT) weapons, ground-based lasers, electronic countermeasures, space mines, X-ray lasers and pellets in orbit.

This year, SDIO's director of its survivability program conceded that survivability is still potentially a show stopper for space-based defenses. He and many other SDI officials and scientists agreed that any single asset in space can be overwhelmed if the Soviets choose to do so. The objective, therefore, is not to ensure survivability of a particular satellite, battle station, or platform in space because that is not possible. Rather, the objective is "functional survivability at affordable cost." That is, SDIO hopes to preserve the function of the system rather than any of its specific hardware.

MULTI-TIERED DEFENSE CONCEPT

	Boost, Post-Boost Phase	Mid-Course Phase	Terminal Phase
Objects	3000 Missiles	~330,000(RV's + Decoys)	30,000 RV's
Hand over to next phase	3000 RV's	300 RV's	30 RV's Delivered
% Leakage	10%	10%	10%

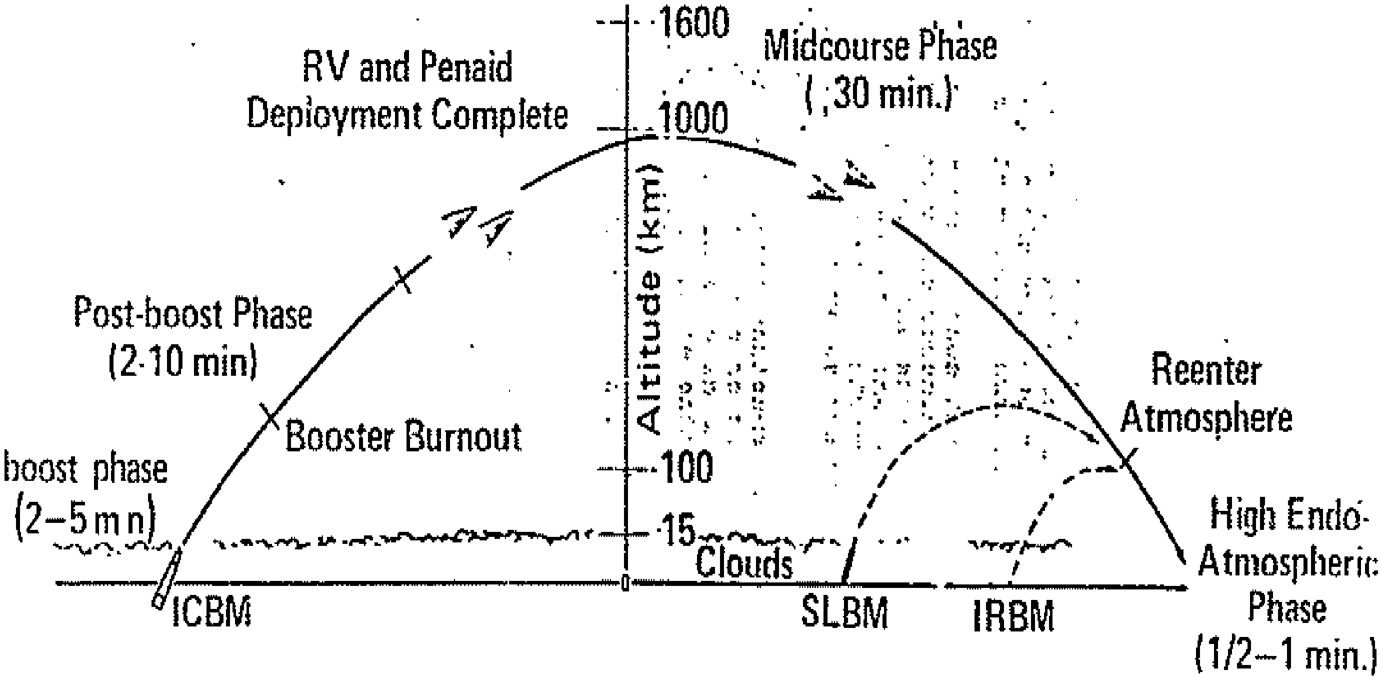


Figure 4

12-A

UNCLASSIFIED

MAC-SDI-8505-193

Moreover, the program director said classical military survivability techniques, such as deception, maneuver, hardening, proliferation, and self defense, apply in the space arena. What makes the techniques difficult for SDI is the fact that the proper combination of survivability measures depends on what the Soviet threat (including countermeasures) will be. This threat changes over time. Quantification, therefore, is "difficult," we were told. Battle stations in any space-based defense system to varying degrees will have to be hardened, maneuverable, equipped with decoys, deployed in large numbers, and be able to shoot back for self defense.

In discussing the cost of assuring survivability, the program director said, "we must avoid the U.S. Navy carrier philosophy of using 80% of the resources to stay alive for more than 20 minutes.

Especially daunting for SDIO is what appears to be two fundamental principles of survivability in space (see Figure 5): 1. the U.S. survivability measure-Soviet countermeasure cycle never ends; and 2. anticipating the Soviet response is always critical. In other words, a strategic defense system that depends on space-based elements can never be completed. The Soviets will develop countermeasures, which we must accurately anticipate and to which we must respond with more survivability measures, or jeopardize our defenses. The cycle is endless.

One problem for the defender is that retrofitting an existing space system, such as adding hardening, is not only unwise, it is difficult to do — especially with thousands of battle stations in space. One cannot, as we do with bombers, fly thousands of satellites to hangers for refurbishment or modernization. And with space launch costs at perhaps hundreds, or more likely thousands, of dollars a pound, replacing satellites with more modern versions will be a very expensive endeavor. Therefore, in building space-based defenses our ability to anticipate Soviet countermeasures becomes crucial.

Last year's report detailed a number of ways the Soviets could attack a space system, such as space-based kinetic kill vehicles (SBKKV's). This year, our briefings turned up new information on countermeasures.

1. ASAT's and Decoys

Scientists at Los Alamos, for example, said they believed the Soviets would respond to U.S. space defenses by attacking the platforms in space. As a matter of fact, Sandia's scientists indicated that in the initial pilot SDI architecture study it was assumed that the Soviets would react mainly with defense suppression such as direct-escent anti-satellite weapons (ASAT's).

One countermeasure not mentioned last year was that the Soviets could build nuclear-tipped direct-ascent anti-satellite interceptors with decoys to overwhelm U.S. space platforms, even if the platforms tried to shoot back. Thus, the discrimination problem, which last year was described as a midcourse-only problem, could well become a boost-phase problem. Space-based kinetic kill vehicles, therefore,

SPACE SYSTEM SURVIVABILITY

SOME FUNDAMENTALS

- FUNCTIONAL SURVIVABILITY AT AFFORDABLE COST IS THE OBJECTIVE
  - ANY SINGLE ASSET CAN BE OVERWHELMED
- CLASSICAL MILITARY SURVIVABILITY TECHNIQUES APPLY IN SPACE ARENA
  - DECEPTION
  - HARDENING
  - SELF DEFENSE
  - MANEUVER
  - PROLIFERATION
- SYNERGISTIC COMBINATION OF SURVIVABILITY ENHANCEMENTS POSSIBLE
  - SCENARIO & SYSTEM DEPENDENT
  - DIFFICULT TO QUANTIFY
- DEVELOPMENT OF TACTICS REQUIRED
- MEASURE/COUNTERMEASURE CYCLE IS OPERATIVE
  - TIME PHASING CRITICAL

UNCLASSIFIED
Figure 5

UNCLASSIFIED

would need interactive discriminators to pick out the real anti-satellite interceptor warheads from the decoys. Those discriminators, however, would not be available for a near-term deployment of SBKKV's.

2. X-Ray Lasers

Another Soviet weapon that could threaten U.S. space systems is the X-ray laser. "The SDI architecture ought to take into consideration the existence of a crude Soviet X-ray laser, and I think SDI has done this," said one Livermore scientist. But he also warned that it is possible the Soviets could have a crude X-ray laser developed by 1995 that could threaten a near-term architecture. If that occurred a near-term deployment by the U.S. would immediately face a significant survivability problem.

Nothing can compare with the X-ray laser as a potent ASAT weapon, the Livermore scientist explained (see Figure 6). Match a very crude X-ray laser against a very sophisticated space-based battle station and "the X-ray laser wins every time," he said. Even 1,000 kilometers away, an X-ray laser beam is still so powerful that it is not economical to shield the battle station. The only way to defeat an X-ray laser, according to this scientist, is to either hide from it or orbit more battle stations than the laser can shoot down.

3. Fast-Burn Boosters

Another Soviet countermeasure SDI scientists are studying intensely is fast-burn boosters. The Soviets would use ICBM rockets that are so fast a space-based system would not have time to engage and attack the missiles. For example, the Soviet SS-18 has a giant, slow booster rocket that requires nearly 300 seconds of burn time, during which it is easy spot from space using infrared sensors. Space-based defenses, therefore, would have a relatively long time to attack the SS-18.

Even before President Reagan's speech initiating SDI, scientists at Livermore Lab were studying how a Soviet fast-burn booster would complicate strategic defenses that used space-based chemical lasers. Similarly, Livermore scientists have examined how Soviet fast-burn boosters would stress a defensive system based on space-based kinetic kill vehicles — that is, space-based rocket interceptors.

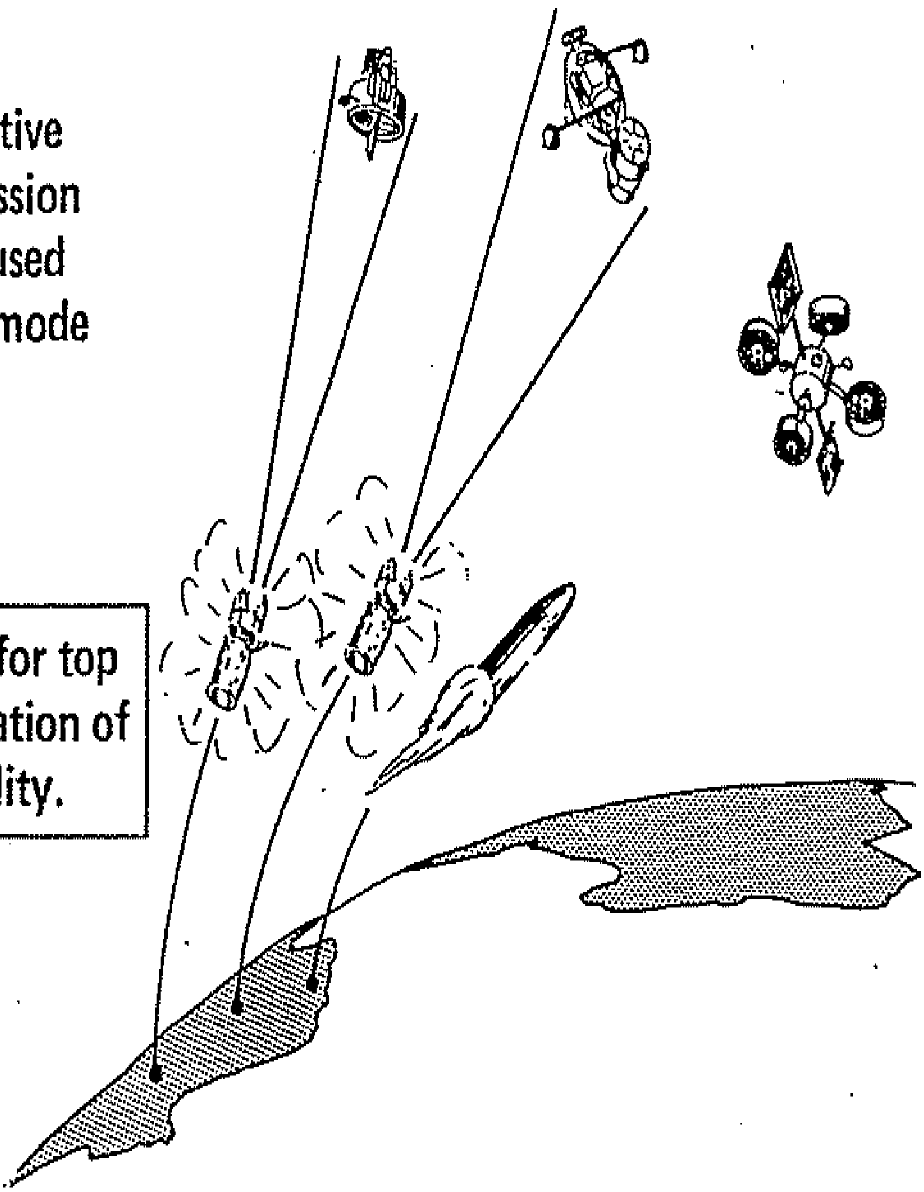
Livermore's studies come to disturbing conclusions for spaced-based kinetic kill vehicles (SBKKV's). One scientist familiar with the studies said: "There is no doubt that for today's (Soviet) SS-18 and SS-24, today's chemical rockets can kill them. The issue is where do you go from here? What's the legacy?" While the SBKKV does a "great job" against the SS-18, "it fails <u>catastrophically</u> for the fast-burn booster," Livermore scientists told us.

Some scientists at the Los Alamos Lab argued that even if the SBKKV cannot hit the Soviet rocket in the boost phase, it could still hit the bus carrying the warheads in the post-boost phase. Lt.Gen. Abrahamson has argued that the Soviet bus is still warm enough to be tracked after the booster rocket burns out. However, a scientist at

Counter-defense role

An x-ray laser
can be an effective
defense suppression
weapon when used
in the pop-up mode

The DTS called for top
priority investigation of
technical feasibility.



UNCLASSIFIED

MKU-XRL-8511-144

UNCLASSIFIED
Figure 6

Los Alamos pointed out that the bus after burnout is two to three orders of magnitude dimmer a target than before burnout. So the target may not be cold, but its emmissions are far fainter after booster burnout. The scientist added that the defense has to know where to look for the bus. And if the defense loses the location of the bus, it probably cannot find it again.

Regardless of how bright the bus is, the Livermore analysis showed that against a fast-burn booster the SBKKV will not be effective against the booster or the post-boost bus. A scientist at the Sandia Lab who specialized in space survivability also concluded that even if a SBKKV system could shoot back at defense surpression threats, it would not be effective against fast-burn or very-fast-burn, direct-ascent ASATs.

The question then becomes, how long would it take the Soviets to build fast-burn boosters with multiple warheads? It would not be an easy task. If the booster burns out at too low an altitude, when the decoys and reentry vehicles are dispensed the thin atmosphere at the edge of space will create atmospheric drag separating the decoys from the warheads. Livermore's scientists, however, discussed a technique one contractor is studying to develop a fast-burn booster and bus that gets the decoys and warheads to a sufficient altitude to avoid atmospheric drag.

Despite the problems the Soviets would have producing them, "the community-wide consensus is that a fast-burn booster is a credible near-term threat," according to one Livermore scientist. A Sandia scientist also pointed out that the Soviet SS-13, while not a fast-burn booster, is a solid propellant rocket that burns in about half the time of an SS-18 — and the SS-13 was 1970's technology the Soviets have already fielded. "You can't argue they can't do it," said the scientist. "They did."

4. Nuclear Blasts

One potential countermeasure mentioned frequently in our briefings was the use of successive nuclear blasts in space to blind infrared sensors and possibly destroy key satellites. Before an attack, the Soviets would explode in space a succession of one-megaton blasts every second or so. The director of SDI's Kinetic Energy Weapons Program conceded that this countermeasure to blind sensors was a significant problem. He acknowledged that if SDI had to deploy a partial SBKKV system in the near term, it might not have this problem solved.

5. Orbiting Patch

At two of the national labs, scientists discussed what might happen if the Soviets responded to our SBKKV system by orbiting a similar system of their own — but the Soviet system would be designed for <u>defense surpression</u> rather than defense. Instead of distributing their platforms equally in orbit, the Soviets might have all the satellites bunched together in an orbiting "patch" in space. When this patch came over the Soviet Union it would attack and overwhelm

the fewer U.S. satellites then over the U.S.S.R., thus punching a hole through which Soviet missiles could escape.

6. Space Mines

Another potential Soviet countermeasure is the space mine, a satellite containing an explosive or other ASAT device, which would trail our most important SDI satellites and explode or attack on command. What was interesting from our briefings this year and last was how readily some scientists and engineers mention "keep-out" zones as part of the defense against space mines, as if we are completely free to establish them unilaterally. What if the Soviets refused to recognize our keep-out zones, especially those that extend over Soviet territory? What if the Soviets turned the tables on us and announced just as our SDI deployment commenced that they were imposing a keep-out zone against all U.S. SDI overflights of their territory? These are questions that deserve much greater analysis than they appear to have received.

D. Midcourse Discrimination

Because the boost-phase will not be able to intercept all Soviet missiles — particularly as the Soviets develop countermeasures — the midcourse defense will be critical. Every missile that escapes the boost phase may carry hundreds of decoys the midcourse defense must track and discriminate from the warheads.

Last year we reported that discriminating decoys from warheads in the midcourse was a critical problem for SDI. If midcourse defenses fail, SDI's terminal defenses, with only about a minute to intercept warheads, will be overwhelmed. SDI determined early in the program that passive sensors could not adequately discriminate decoys from warheads. (Passive sensors such as infrared detectors pick up only the naturally occurring emissions from an object.) Although there has been encouraging work with active sensors, such as radar and lasers that bounce low-powered beams off targets, the general consensus still appears to be that interactive discrimination is essential to midcourse discrimination — particularly against a responsive Soviet threat. In interactive discrimination, a low-powered neutral particle beam, for example, is fired at an object to disturb it, whereupon a separate detector picks up the disturbance to determine if the object is a warhead or decoy.

The neutral particle beam appears to be a promising area of research for interactive discrimination. A linear ion accelerator propels ions to velocities close to the speed of light and then strips the extra electrons off the ions to create neutrally charged particles, which are shot at the target. Building a linear accelerator is not new. Physicists have been constructing them since 1947. But building a neutral particle beam accelerator light enough to be lifted into space that can survive and operate unattended in the nuclear background of a Soviet attack is a severe technological challenge. (This challenge will be discussed further in the next section.)

According to Sandia scientists, who are bullish on the neutral particle beam concept, resolving these questions will not stretch our understanding of physics. Yet they pose serious engineering problems nonetheless. Furthermore, some of these problems, we were told, can only be addressed in space experiments.

In any event, the neutral particle beam project is aiming for a full-scale engineering development decision by the mid-1990's, at the earliest. Sandia's scientists envision a deployment no earlier than the year 2000. Therefore, it is clear we will not have a reliable interactive discrimination system for the midcourse defense in the near term.

Finally, keep in mind that it was the advent of the beam and laser weapons that initially gave the President and his advisers hope that a comprehensive strategic defense is possible. As it has turned out, these directed energy weapons may well represent the only hope of overcoming Soviet countermeasures against U.S. strategic defense. But it will take years of intensive research before we know whether these weapons are militarily feasible. Moreover, SDI scientists and engineers we interviewed emphasized time and again that little can be said about the wisdom of deploying any defensive technologies until the costs of the system and the costs of defeating or circumventing it are known. Yet accurate cost data are not available for even the most mature technologies, such as kinetic energy weapons. As a Livermore scientist said, "Nobody's capable of costing a single platform yet."

IV. REORIENTATION TO NEAR-TERM OPTION

The Strategic Defense Initiative Organization is reorienting its program to pursue vigorously the option of a near-term deployment of ballistic missile defenses.

None of the SDIO officials who briefed us would admit that this is what is happening in their program. However, after examining closely the SDI budget for FY1987 and FY1988 and after analyzing the shifts being made in key SDI projects, it is clear that this reorientation toward a near-term option is well under way. Furthermore, it appears that this reorientation began in the winter of 1986, with a number of last-minute changes in the FY1987 SDI budget priorities and is continuing under new priorities reflected in the submission of the FY1988 SDI budget.

This reorientation leads us to one of two conclusions — either of which has disturbing implications:

1. The reorientation of the SDI program toward a near-term deployment option is proceeding without formal or public presidential consent and without congressional approval, or

2. The reorientation is proceeding with secret presidential consent, but Congress is largely unaware of the decision, because so far Congress has concerned itself with the topline funding for SDI. Congress has refrained from dictating individual aspects of SDI or micromanaging its program.

The question of who has decided that this reorientation should occur and who knows about this reorientation is clouded even further by other pieces of information collected during the research for this report:

• It is clear that members of Congress are being told conflicting stories by SDIO about its overall plan for a near-term deployment. Some members and their staffs reportedly are being told such a plan exists, while we were told no plan exists. In fact, SDIO refused to provide us a briefing on a near-term deployment architecture because it claimed none existed.

• It appears that key parts of the Administration — particularly in the Department of State and the Arms Control and Disarmament Agency — have been kept in the dark about SDIO's programatic reorientation toward a near-term deployment.

• SDIO officials and managers told us repeatedly that they knew of no move to reorient their program toward a near-term deployment. However, it is clear, based on information we have received from a number of sources, that General Abrahamson has been going to project managers, contractors and systems designers in his program and either asking for proposals to deploy in the near term or directing that a particular activity be reoriented to pursue a near-term option. What is more, the briefing slides General Abrahamson's program managers use to brief him and other top DoD officials, now often tout a particular

program's ability to complement a near-term deployment or enhance it in the future.

• There is also considerable evidence, based on our review of the program, that SDIO may be rushing to deploy or demonstrate whatever can be produced in the near term with little thought given to how the items would be integrated into an overall architecture or with less attention paid to the follow-on technology that would be needed to produce an operational system. In other words, a "demonstrate now" momentum may be taking hold as much as a "deploy now" momentum in the program.

A. Programatic Changes

What follows is a description of some of the key research activities conducted within SDI with analyses provided for instances in which the activities are being reoriented. A particular activity's reorientation might not signal a reorientation of the entire program. But when pieced together with the reorientation being pursued in other activities, the picture becomes clear.

Many SDI managers claimed the reorientation of their research activities was prompted by Congressional budget cuts. Indeed, Congressional cuts forced a scaling back of ambitious plans for the entire program. However, because Congress has only decided the topline funding figure for SDI and avoided micromanaging the program, SDIO's director has had wide latitude in setting priorities within the program. Clearly the new priorities being established to pursue a near-term option are compelled by a conscious decision on SDIO's part to do so, not by budget cuts. Congress appropriated more than enough money for SDIO to pursue its program in FY87 as it was envisioned in early FY86, before the push for near-term deployment began.

1. Directed v. Kinetic Energy Weapons

It has been in its Directed Energy Weapons Program that SDI has pursued the strategic defense weapons and interactive discriminators that would be used in a far-off system. Such a system, if it were even possible to build in a cost-effective and survivable manner, would not be deployed until the early 21st century. Such a system also would embody the President's vision of a shield, which would protect the U.S. against a responsive Soviet offensive nuclear threat — that is, a Soviet threat employing countermeasures and defense supression capabilities.

On the other hand, in the Kinetic Energy Weapons Program SDI is researching ground- and space-based rockets that it has envisioned would be deployed sooner or before the end of the century. However, the military effectiveness of these interceptors — particularly the space-based ones — would decrease as the Soviets' responsive threat evolved over time. It is envisioned that the directed energy weapons and interactive discriminators would come on line to meet the responsive threat that kinetic energy weapons could not handle. (Figure 7 provides a useful guide on how the various weapons, sensors and control systems are blocked out in the program and architecture.

Source: General Accounting Office

STRATEGIC DEFENSE INITIATIVE PROGRAM

	TERMINAL PHASE	MID-COURSE PHASE	POST-BOOST PHASE	BOOST PHASE
SYSTEM ARCHITECTURE	DESIGN PLANS FOR MULTI-LAYERED BMD SYSTEM			
BM/C3	BRAIN OF SDI SYSTEM NECESSARY FOR ATTACK CHARACTERIZATION, WEAPON RELEASE, TARGET ASSIGNMENT & INFORMATION MANAGEMENT			
SENSORS	TERMINAL IMAGING RADAR SYSTEM	SPACE SURVEILLANCE AND TRACKING SYSTEM (SSTS)		BOOST SURVEILLANCE & TRACKING SYSTEM
	AIRBORNE OPTICAL ADJUNCT SYSTEM	NEUTRAL PARTICLE BEAM DISCRIMINATION SYSTEM		
		LWIR PROBE		
WEAPONS	HIGH ENDOATMOSPHERIC INTERCEPTOR SYSTEM	ERIS INTERCEPTORS	GROUND-BASED LASER SYSTEM	
		SPACE-BASED KINETIC KILL VEHICLE SYSTEM		

Figure 7 UNCLASSIFIED

UNCLASSIFIED

Figure 8 depicts the deployment path the program hopes to take to achieve thoroughly reliable defenses.)

In general terms, what has happened in the FY87 SDI budget and its proposed FY88 budget is that the funding priority has shifted dramatically from the Directed Energy Weapons (DEW) Program to the Kinetic Energy Weapons (KEW) Program.

In FY87 the DEW Program's budget was cut in half from the originally requested amount, while the KEW Program suffered only a minor reduction. (See Figure 9 for a comparison of the requested and appropriated amounts.) Furthermore, the DEW Program cut was disproportionate compared to the other programs. Forty-eight percent of the total $1.6 billion in reductions for FY87 came out of the DEW Program budget. Only 16% of the total reductions for FY87 came out of the KEW program budget.

On the other hand, in FY86 the distribution picture was reversed. The KEW Program budget was cut twice as heavily as the DEW program budget. Of the $967 million in reductions made from the FY86 request, 27% came out of the KEW budget and 13% came out of the DEW budget (see Figure 10.)

In FY88, it appears that the budget priority again shifts from the KEW to the DEW program. Keep in mind, SDIO is requesting a large increase in funding for both programs. But its proposed increase for the DEW program is substantially less than what had been previously projected. Last year SDIO projected it would need about $1.615 billion in FY88 for the DEW program. Now, SDIO says it needs only $1.009 billion for DEW in FY88, a whopping $606 million reduction. By comparison, SDIO said last year it would need $1.217 billion for KEW in FY88. This year, SDIO says it needs $1.074 billion for KEW in FY88, only a $143 million reduction.

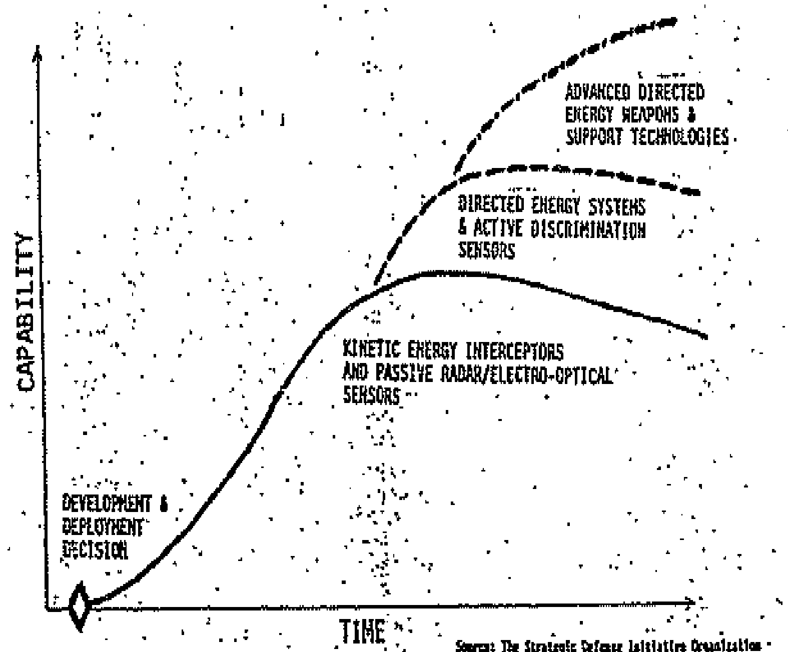
The Department of Energy executes most of SDI's work in nuclear-directed energy plus considerable work in space power. The Energy Department's SDI budget has been scaled back drastically from what had been projected. For FY88, for example, DoE originally projected an $811 million budget for SDI research. The current request is for $569. Last year DoE projected an $831 million budget for FY89. This year it says only $490-$540 million is needed. (See Figure 11 for DoE's SDI funding level.)

Both the KEW and DEW program managers insisted that the reorientation of the two projects is not due to any move toward near-term deployment. The DEW program manager maintained, for example, that the reorientation was being forced by "a realization of what we have to accomplish in KEW" and by a "more mature attitude" toward the DEW program. Before, the DEW program "was trying to work all the problems," the DEW manager said. "Now, we are seeing KEW technology being integrated more into the SDI mission."

Program impact data supplied by SDIO shows, however, that the shift in funding appears to have resulted in not so much a maturing of the DEW program, but rather a delay in its technical progress.

UNCLASSIFIED
Figure 8

THE PATH TO "THOROUGHLY RELIABLE" DEFENSES



Source: The Strategic Defense Initiative Organization

UNCLASSIFIED

Figure 9

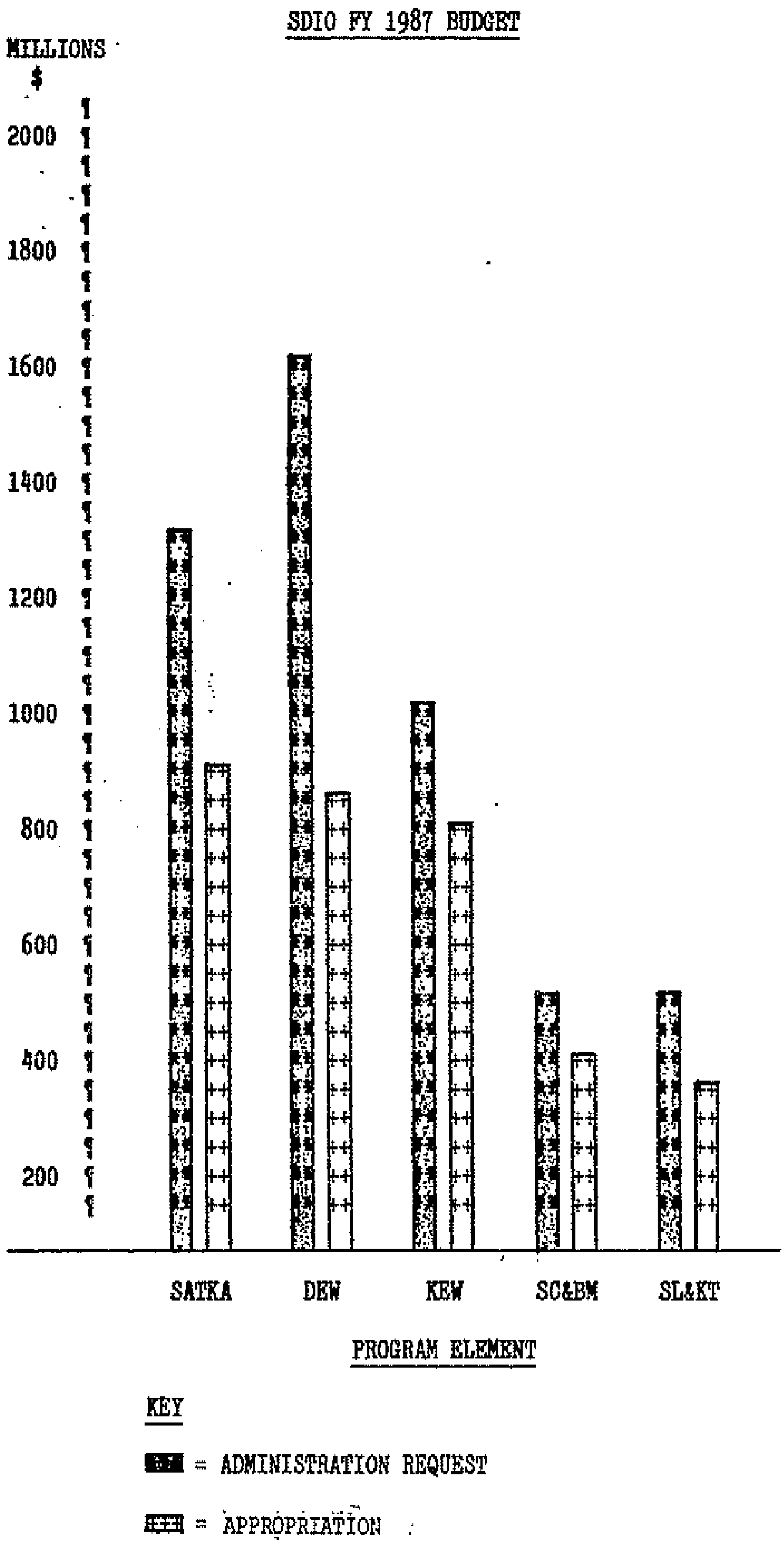

SDIO FY 1987 BUDGET
MILLIONS $
2000
1800
1600
1400
1200
1000
800
600
400
200
SATKA
DEW
KEW
SC&BM
SL&KT
PROGRAM ELEMENT
KEY
= ADMINISTRATION REQUEST
= APPROPRIATION

Figure 10

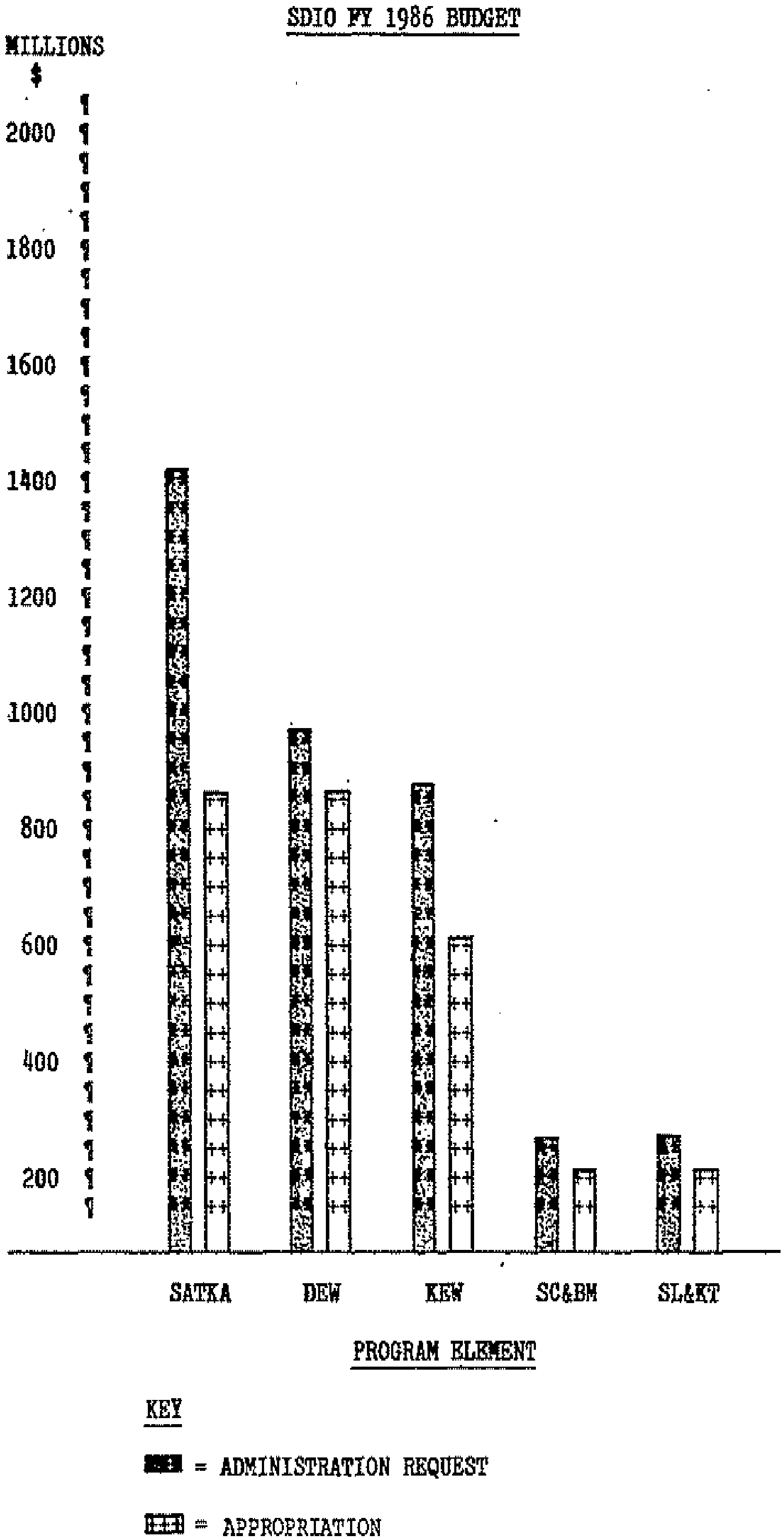

SDIO FY 1986 BUDGET
MILLIONS $
2000
1800
1600
1400
1200
1000
800
600
400
200
SATKA
DEW
KEW
SC&BM
SL&KT
PROGRAM ELEMENT
KEY
= ADMINISTRATION REQUEST
= APPROPRIATION

Figure 11

DEPARTMENT OF ENERGY SDI FUNDING

(millions)

FY1985 Approp.	FY1986 Approp.	FY1987 Approp.	FY1988 Req.	FY1989 Req.
$224	$288	$317	$569	$490-540

Initiation of the neutral particle beam ground and space experiments have been delayed. Also delayed will be the free electron uplink experiment and a portion of the nuclear directed energy research. Advanced technology research for chemical lasers has been reduced in scope, as has the research into the tracking and pointing experiment and the space relay mirror.

By itself, the shift in funding from the DEW program to the KEW program would not be conclusive evidence that the program is shifting to a near-term deployment. But taken together with the priority shifts occurring <u>within</u> both the KEW and DEW programs plus the shifts occurring within the other programs such as space transportation, the conclusion becomes inescapable that SDI is in fact moving toward the near-term option. What is more, the shifts within the programs indicate that far-term technology research efforts in many instances are being scaled back to accommodate near-term research priorities.

Before considering the research efforts leading toward a near-term deployment, a further mention will be made of some of the DEW technologies SDI is pursuing.

2. Free Electron Laser

During the past three years SDIO has revised its thinking considerably on the characteristics its lasers should possess to be militarily useful directed energy weapons. For example, SDIO now believes that moving to short wavelength lasers that involve the placement of fewer assets in space is the more militarily effective option to pursue. For that reason, we saw a shift in program emphasis last year from the space-based chemical laser to the ground-based free electron laser. The ground-based free electron laser system is believed to involve fewer critical assets placed in space (see Figure 12). In addition, the free electron laser itself has advantages over other conventional lasers in terms of wavelength tuning, high power capability, good optical quality, and high efficiency.

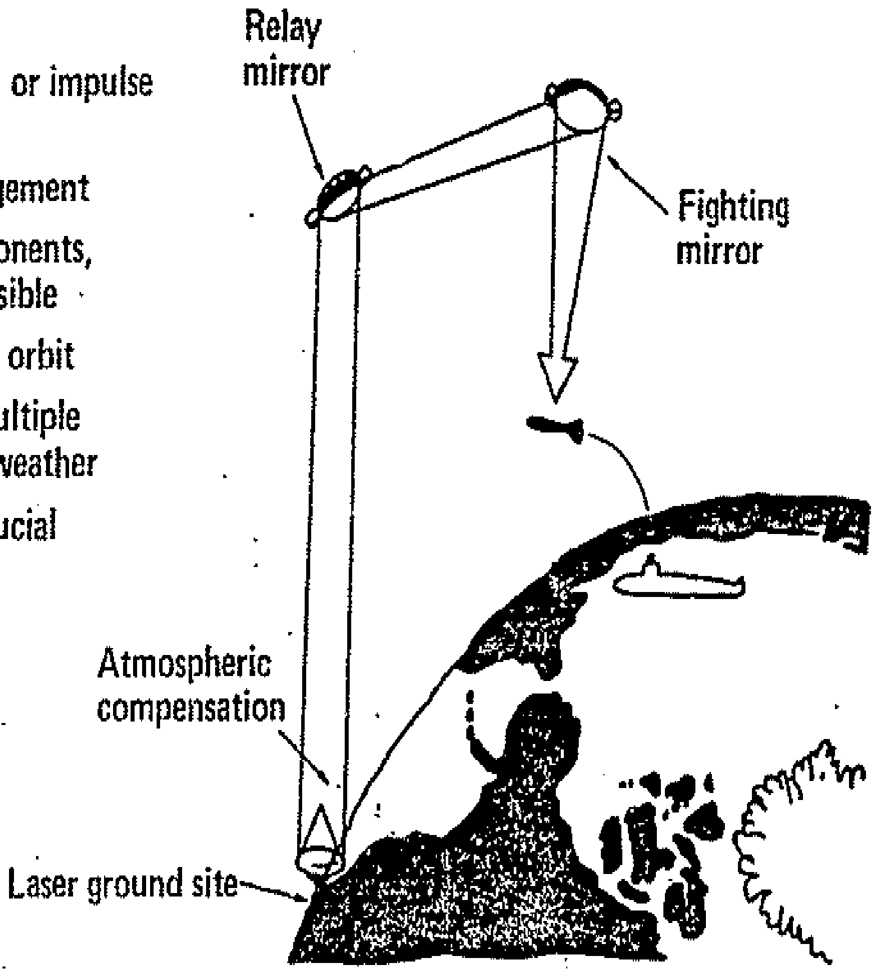
SDIO's free electron laser program, however, has undergone some "political turbulence" the past year, as the program's scientists readily admit. The controversy has centered on which of two types of lasers should be emphasized in the SDI program: the radio frequency linac free electron laser or the induction linac free electron laser (see Figures 13 and 14 for a depiction of both lasers).

The initial RF linac free electron laser is being developed by Boeing Co. while Los Alamos Laboratory is conducting theoretical research into a more high-powered version of the laser. Research into the induction linac free electron laser at this point is being handled entirely by the Livermore Laboratory. The main difference between the two lasers is the type of accelerator used.

Either laser has advantages and disadvantages over the other. The controversy surrounding the two lasers is too complex to be described fully in this study. In a nutshell, serious concerns had been raised in the scientific community that SDIO was prematurely selecting one laser over the other for a large-scale demonstration

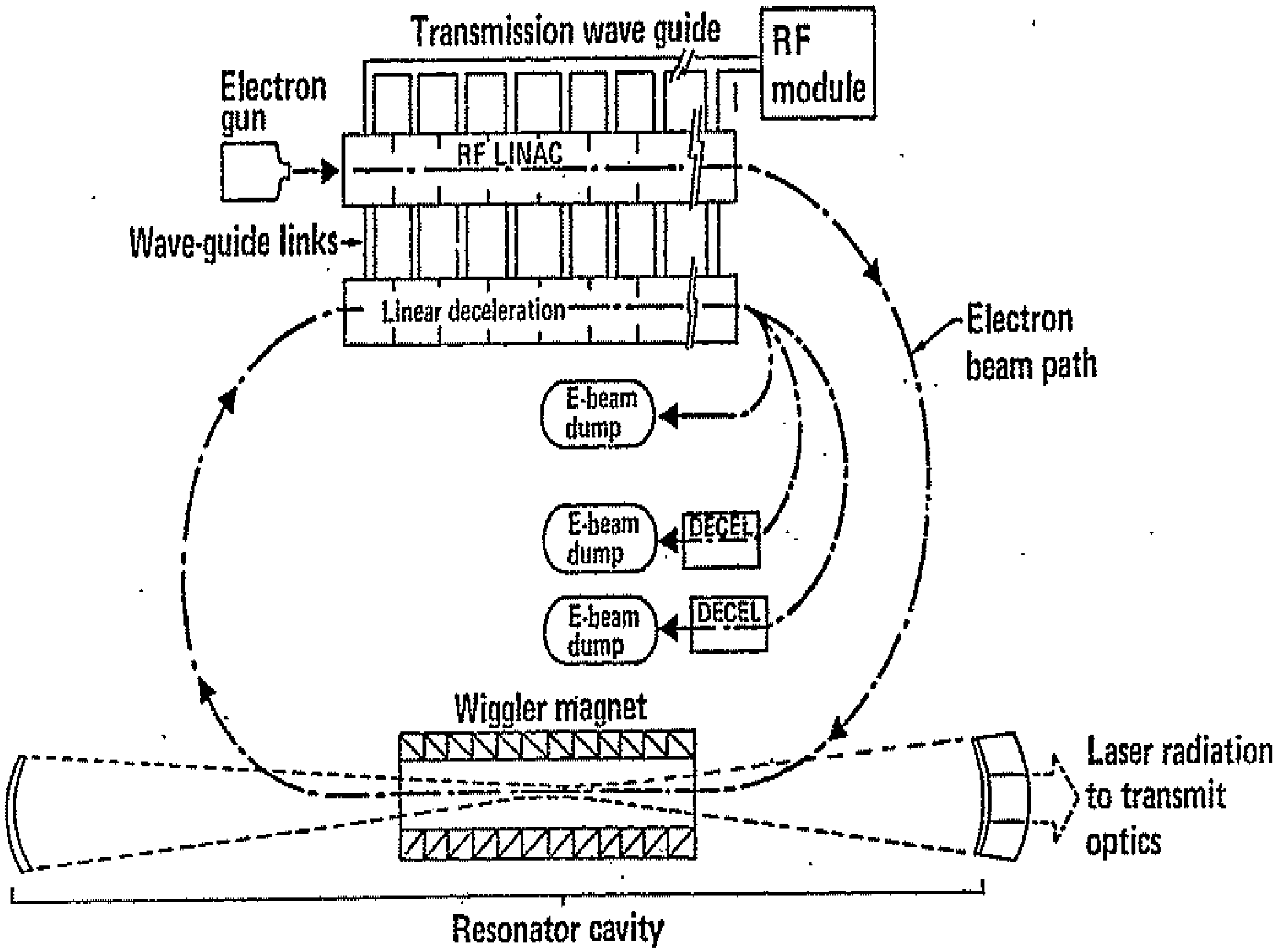
Ground-based laser relay

- Sequential thermal or impulse kill
- All phases of engagement
- High energy components, prime power accessible
- Reduced weight in orbit
- Several lasers at multiple sites to overcome weather
- Adaptive optics crucial



UNCLASSIFIED

RF LINAC FEL



- Low current
- Multi-pass extraction
- E-beam energy recovery

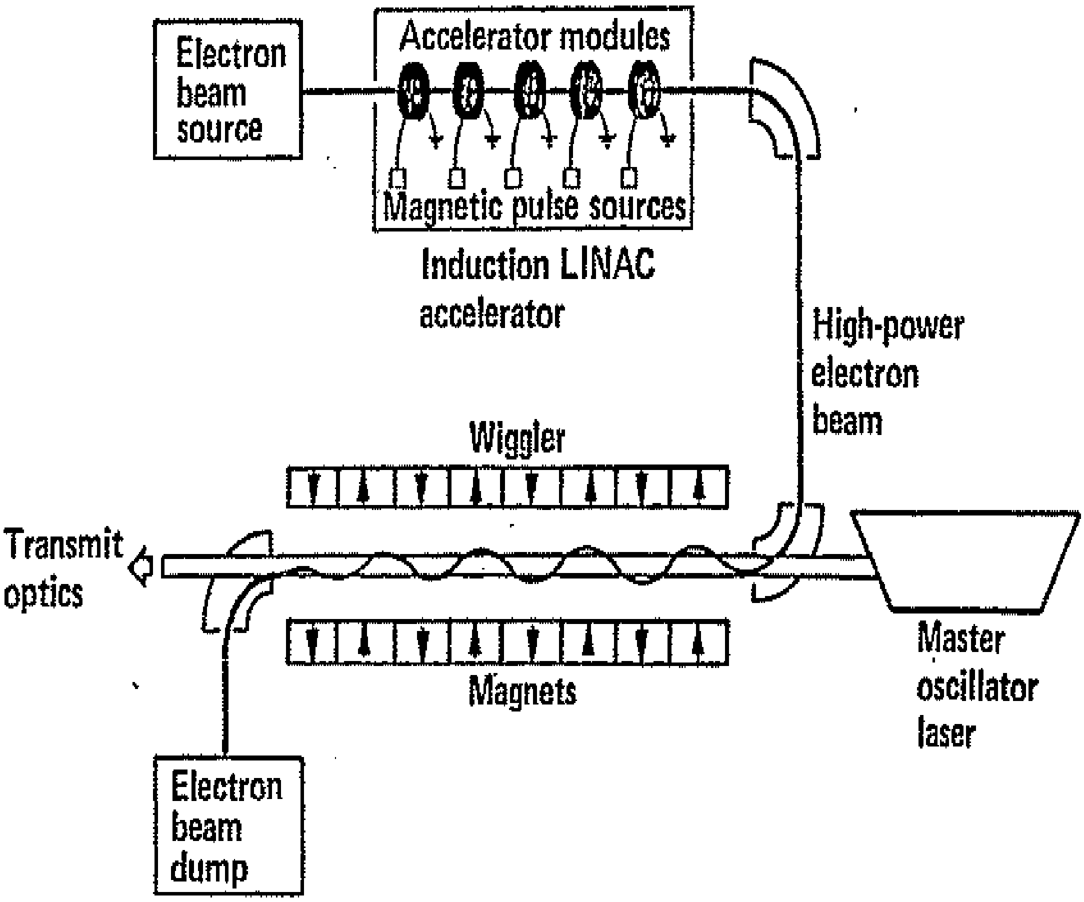
UNCLASSIFIED

MAU-DEW-8504-74

UNCLASSIFIED
Figure 13

UNCLASSIFIED

Induction LINAC FEL



- High current
- Single pass extraction
- High output power density

Figure 14

project before the necessary basic research had been completed.

The FEL program, however, has now stabilized, according to the scientists involved in its research. A selection of the RF or induction laser has been delayed for about a year as more research is conducted on the two concepts and an outside committee evaluates the pros and cons of each system. As the program now stands, a decision will be made in on which laser will be used for testing at the White Sands Missile Range. Beginning in SDIO hopes to build a test laser (either RF or induction linac) to demonstrate that a low-powered FEL beam can compensate for atmospheric disturbances and be sent from the ground to a target in space. It must be noted that this first "uplink" experiment in would not involve a mirror in space reflecting the beam back to earth. All that would be in space is an instrumental test vehicle with a beacon to receive the FEL beam and analyze it. In the follow-on uplink experiment in which also will not involve a mirror in space as currently configured, SDIO hopes to demonstrate that a laser beam can be transmitted to space. (A would be needed for battle weapons.)

Producing a militarily capable ground-based laser will be a monumental undertaking for SDIO (see Figure 15 for a more detailed depiction of the components of a ground-based laser system). First a device to produce the laser beam must be built, which Los Alamos, Boeing, and Livermore are presently undertaking and which still involves numerous technical hurdles to overcome.

Next a beam control system must be built to receive the laser beam and prepare it for passage through the atmosphere. This will be no small undertaking. For a laser beam, the atmosphere changes 1,000 times a second. The beam passing through the atmosphere will have to be adjusted at least that frequently. A low-energy laser beacon will have to be fired from the relay mirror down to the ground-based system to tell it how the atmosphere is changing. That laser must have a capability to produce pulses per second. The current capability for such a laser is . In the adaptive optics system, a cooled deformable mirror with actuators will be needed by for beaming the laser up. Current state-of-the-art technology can produce a cooled mirror with actuators.

The experiments would demonstrate the first two steps of the ground-based laser system. The third step consists of the space-based relay and battle mirrors that must be built to take the beam and direct it toward a Soviet missile. Developing these mirrors was described by one expert close to the program as "a horrendous problem." SDIO's research into these space-based mirrors, however, has been drastically scaled back for the moment resulting in significant risks for the ground-based laser effort. That risk is that we may have the ground-based portion of a prototype system on line beginning in the mid 1990's but we will not have the space-based mirrors ready to complete the system.

The uplink experiments will be extremely expensive. The first phase of the experiment alone could cost as much as $750 million. It

would be an unfortunate development if all that money were poured into generating the FEL beam with no mirrors being developed to direct the beam to a target.

No firm dates exist for when a fully capable FEL weapons system might be available. In fact, serious questions remain as to whether an FEL weapons system might ever be available for ballistic missile defense. It may be that the only reasonable role for FEL's is as an anti-satellite weapon fired from the ground. SDIO's architecture studies, nevertheless, envision ground-based FEL's coming on line in the next century. If that goal is realized, the eventual full deployment would be huge. One proposed architecture, for example, calls for ground-based sites with lasers at each site (the building for each site would be one mile long), plus relay and battle mirrors in space.

3. Neutral Particle Beam Research

SDI's goals for neutral particle beam research were reoriented significantly last year. A neutral particle beam is a stream of uncharged atomic particles travelling at nearly the speed of light, which would penetrate a missile's outer layer and destroy its inner workings. SDIO soon realized, however, that neutral particle beams were a long way off from becoming militarily useful weapons in the boost or post-boost phase of defense. Therefore, last year NPBs took on a more important role -- a role forced by a likely inadequacy of the midcourse defense.

As noted before, the key hurdle SDI faces in the midcourse is discriminating warheads from decoys. SDI has come to the conclusion that passive sensors, such as infrared detection devices, could not handle the discrimination job in a nuclear environment, particularly if the Soviets countered with thermal masking of their warheads. However, when a neutral particle beam is fired at an object, the object emits neutron and gamma rays in proportion to its mass and size. SDI scientists thus believe they can build a NPB device that would tap warheads and decoys, with a nearby detector device picking up the neutron and gamma ray emmissions to discriminate between decoys and heavier warheads (see Figure 16). This is called interactive discrimination.

To handle up to warheads and perhaps or more decoys streaming through the midcourse, SDIO envisions deploying a formidable force of interactive discriminators. One SDI architecture under study, for example, calls for placing in space neutral particle beam accelerators to tap the objects plus detectors to pick up the emmissions. To achieve such a constellation would be a tremendous undertaking, one that would likely not be fully operational until the 21st century.

Building prototype models of the NPB accelerator and the detector would require significant advances in engineering and physics. However, the real hurdles to achieving such a militarily capable system are, first, reducing the weight of a space-based accelerator and detector. For example, Los Alamos believes that the weight must

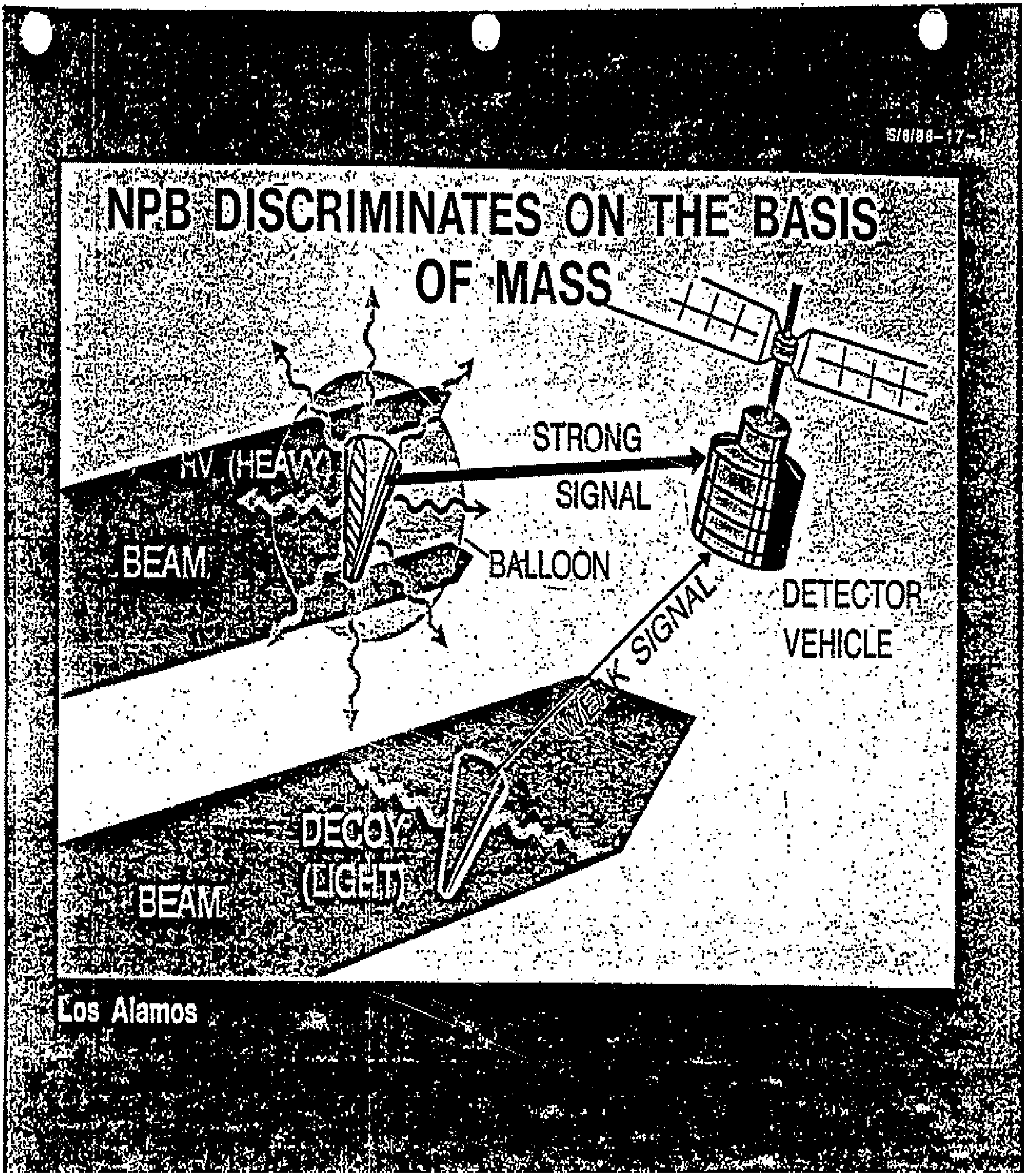


Figure 16

UNCLASSIFIED

UNCLASSIFIED

be reduced from 300 metric tons per platform (the current capability that would cost a total of $2 billion to put in space) to a battle-ready platform of just 30 tons (see Figure 17).

Second, current rudimentary accelerators on the ground take weeks to start up and then must be constantly fined tuned by technicians when they are running. In space, the accelerator must start within a matter of minutes and must be fined tuned in space by remote control. Furthermore, the device that supplies the ions to the accelerator is notoriously fickle. Can this ion source be turned on remotely? Will the spacecraft itself become charged electrically and affect the creation of the neutral particle beam?

Third, once the components are constructed and downsized, piecing them all together into an effectively operating discriminator will be "a real problem," according to scientists working on the NPB project.

Fourth, the electrical power requirements to operate the neutral particle beam accelerator are much greater than anything ever supplied in space. Something on the order of might be required depending on whether the device is used as a discriminator or weapon. Some scientists envision the power supplied by rocket motors turning turbine generators. Will hot gases emitted by the rocket motors get in the way of the beam? What sort of vibrations and platform rotations will be caused by these motors, and will they disturb the beam weapon's tracking and pointing accuracy?

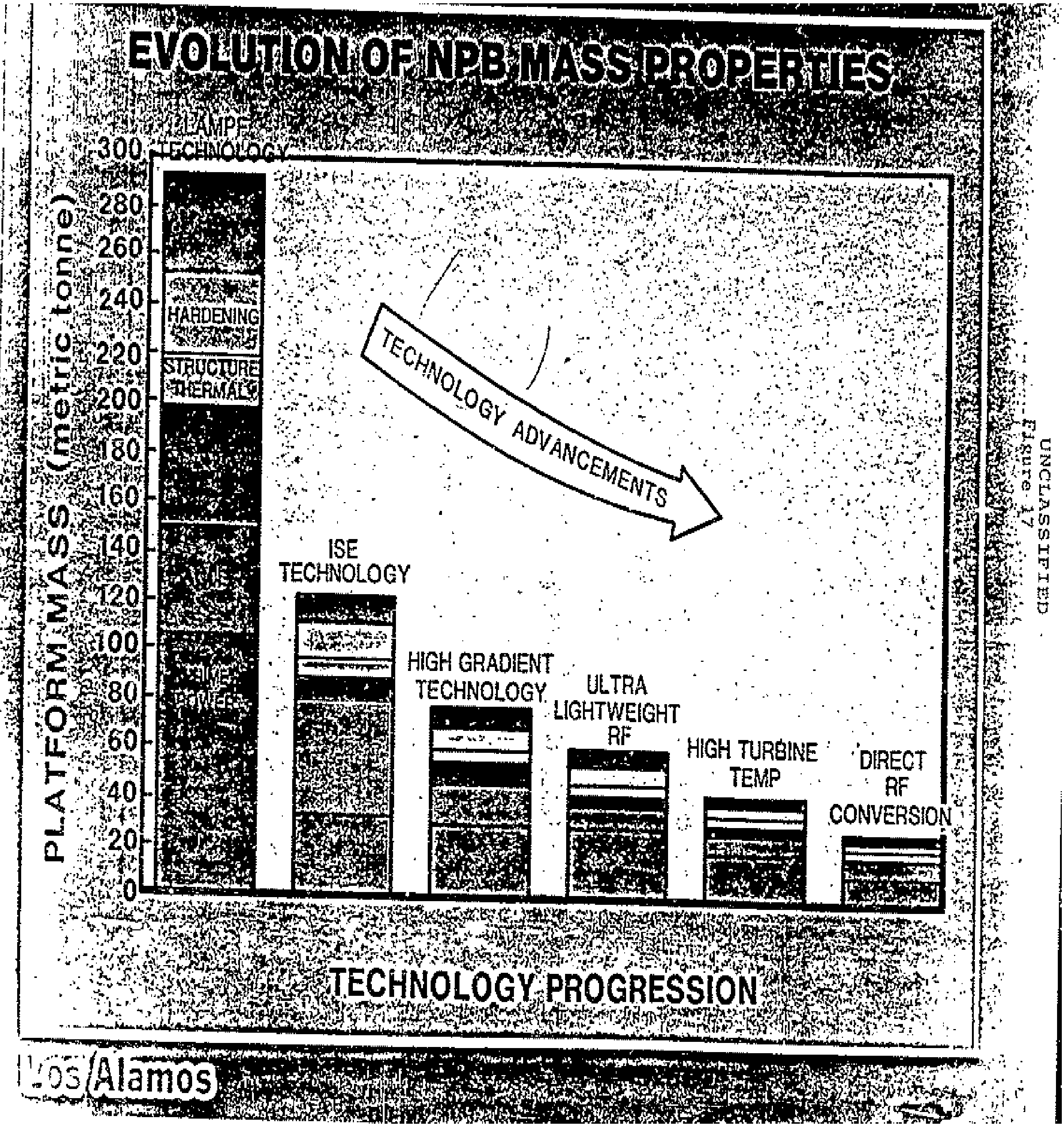
Last year, SDIO officials had ambitious plans for NPB interactive discrimination. The organization was planning two ground test experiments of the accelerator, plus an integrated space experiment (ISE) in that would cost $750 million. In response to questions raised last year concerning the tremendous cost of this one space experiment, SDI officials insisted that the ISE was critical to resolving issues concerning the accelerator's operability in space.

For the moment, however, SDIO has pulled the plug on the space experiment. All funds for the detailed design, fabrication and testing of a space-based accelerator have been deleted in the FY87 budget. An SDI official said that the FY87 funds were cut because they are "trying to redefine the minimum essential thing we need to do in space" and that funds have been requested to restart the ISE in FY88. However, concerns are being raised, even within the program, that cutting the FY87 money will result in key contractor and service personnel drifting off to other projects and ultimately will result in the ISE being terminated rather than delayed.

The funding cut is also noteworthy considering the high priority SDIO assigned last year to NPB interactive discrimination. Last year, SDI officials concluded that midcourse discrimination with these devices was absolutely critical to achieving robust strategic defenses against a responsive Soviet offensive threat. Now, one of the key, albeit expensive, experiments in that path to effective midcourse discrimination has been abruptly halted for the moment. As will be noted later, a near-term deployment would have little if any midcourse discrimination capability. This particular funding cut may be one

UNCLASSIFIED

Figure 17



V-21

UNCLASSIFIED

indication of far-term research efforts being scaled back to meet near-term needs.

4.

While NPB interactive discrimination is a far-term option at best, SDI officials now believe that may have nearer-term applications for picking out warheads from decoys. would involve hypervelocity pellets driven by a nuclear explosion — a sort of nuclear shotgun that would strip away decoys revealing warheads in the threat cloud. While some physical principles have yet to be proven, Los Alamos scientists are encouraged by preliminary experiments conducted in this project.

Furthermore, SDI officials, who speculate that may have more near-term potential than neutral particle beams, have ordered an acceleration of this project. They have also requested extra funds in the FY87 supplemental appropriations request submitted to Congress in order to do concept verification work on

5. Far-term Innovative Technologies

There has been considerable Congressional support in the past for the SDI program exploring far-term innovative technologies. While Members might disagree on the overall feasibility of an SDI system, there is general agreement that the U.S. does not want to stop BMD technology in its tracks, and that we should explore innovative and promising new technologies. To its credit, SDIO spared the "Innovative Science" work packages in its FY87 budget from any substantial cuts. These Innovative Science contracts make up only 3% of SDIO's FY87 budget, but they are an important part nonetheless.

There are, however, some disturbing signs in the funding realignment for FY87 that may indicate that far-term innovative technologies might soon take a backseat to near-term considerations. For example, while the Innovative Science budgets for the Sensors, Systems and Support programs increased or remained essentially the same as a result of the FY87 funding realignment, the Innovative Science programs in DEW and KEW took drastic cuts.

In some instances, high-risk research in far-term technologies are being scaled back. For example, at the Sandia Laboratory there is project Delphi (for Discriminating Electrons with Laser Photon Ionization). As the Soviets develop a responsive threat with countermeasures, the Airborne Optical Adjunct System (AOS), whose passive sensors are to provide tracking and discrimination in the late midcourse and early terminal phases, will become less effective. Delphi, a pop-up system which uses a laser beam to in effect weigh and sort decoys, could be used for high value targets as a short-range discriminator in the late midcourse and early terminal phases. It would augment AOS, taking up the discrimination role as the capability of the airborne passive sensor decreased. However, Delphi's proposed budget in FY87 of $20 million was eventually cut to $6 million. And its FY88 budget request of $22 million, in effect, represents a freeze in funding from the FY87 request.

By itself, a funding reduction in a single effort does not lead to the conclusion that the entire far-term innovative research effort is being sacrificed for the near term. However, at various points in the SDIO budget for FY87 we see evidence of such priority shifts. Furthermore, scientists involved in SDI research worry that the shifts away from far-term technologies will become even greater as the near-term deployment option takes hold. "We've already seen this problem with the STAR demonstration projects," said one scientists. "A near-term deployment will just accelerate that problem."

6. Ground-based Interceptors

The ground-based interceptors that will defend the U.S. in the midcourse and terminal phases of the attack are ERIS (exoatmospheric reentry vehicle interceptor subsystem) and HEDI (high endoatmospheric defense interceptor). Both systems would be non-nuclear. ERIS would attempt to destroy Soviet warheads in the midcourse phase, while HEDI would attempt to destroy the re-entry vehicles that escaped midcourse defenses and made it to the terminal phase.

Current architectures envision or more ERIS interceptors deployed in a far-term robust defense, backed up by as many as HEDI interceptors in the terminal phase — a staggering number, larger than our current ICBM fleet. Later sections of this report will consider the not-so-insignificant technological hurdles that must be crossed just to achieve a limited near-term deployment of these missiles. For the moment, we will consider the early experiments and funding planned for these systems.

The current research for ERIS and HEDI is divided into two phases:

— the technology validation experiment for each interceptor, aimed at building a prototype model that will be test fired in 1990-91 to demonstrate critical technology issues, and

— advanced technology research to produce by the mid 1990's an operational interceptor that is smaller, lighter, less expensive and more capable.

The total cost of just the validation experiments for both interceptors will be enormous — $794 million for ERIS and $979 million for HEDI. No total cost estimates have been made for the advanced technology research.

For FY87, however, SDIO has reoriented the HEDI and ERIS budgets in a way that has serious implications for what the two programs are seeking to achieve. Funding for both projects' technology validation experiments was scaled back minimally, by 9%. The $102 million request for ERIS was trimmed to $97 million; the $110 request for HEDI was reduced to $95 million. However, funding for the two projects' advanced technology research was slashed drastically, by 75%. The $20 million request for ERIS was cut to $4.5 million, while the $38 million request for HEDI was cut to $10 million.

Military Uses of Space: 1946-1991

Published by:
Chadwyck-Healey Inc., 1101 King Street, Alexandria, Virginia 22314

Military Uses of Space: 1946-1991 provides a detailed record of the strategic importance of the U.S. military space program from the conceptualization of the uses of space to the present realization of advanced capabilities. Materials were identified, obtained, assembled, and indexed by the National Security Archive, a non-profit, Washington, D.C. based research institute and library. The microfiche collection is accompanied by Military Uses of Space: 1946-1991 Guide and Index.

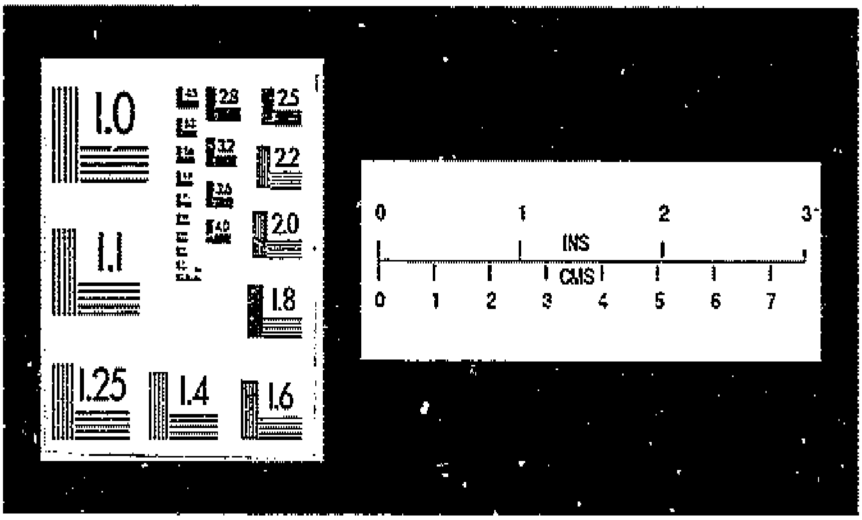
Arrangement of Information on the Microfiche:
The documents are arranged in chronological order. A unique identification number is assigned to each document. Each new document begins a new line on the microfiche.

Document Quality:
The quality of the original material varies. In the case of each document, Chadwyck-Healey Inc. has filmed the best copy made available by the National Security Archive.

Microfiche Numbering:
The unique identification numbers assigned to the documents are listed in the top right hand corner of the microfiche title strip.

Technical Data:
Producing Laboratory: Chadwyck-Healey Inc.
Date of Publication of Microfiche Edition: 1991
Format: 49 frame, 105mm x 148mm silver halide microfiche, 24x nominal reduction

Distribution Outside the USA:
Chadwyck-Healey Ltd., Cambridge Place, Cambridge CB2 1NR, England



Document Quality:

Through the use of the Freedom of Information Act and an extensive network of government, media, and academic contacts, the National Security Archive has developed this varied collection of primary materials. Just as the type of materials included varies, so does the quality of each document.

The National Security Archive has made every effort to provide Chadwyck-Healey Inc. with the best quality, most complete copy available of each document. Chadwyck-Healey Inc. has faithfully reproduced on microfiche exactly what was provided by the National Security Archive.

Many of the documents included in this publication were previously classified by the U.S. Government and even when declassified, sections or pages may be obliterated by the government due to the potentially sensitive information contained in them.

The variety of material reproduced in this publication includes photocopies or poor carbon copies of cables, memoranda, intelligence reports, briefing papers, Congressional reports, official letters, and press reports. This variety can present difficulties of image and contrast which the most careful filming and processing cannot entirely overcome.

This is a rich and varied source of primary documents made available for research and all microfiche have been produced to the highest quality and conform to AIIM, BSI and ANSI standards.

The initial technology validation experiments are certainly essential parts of the ERIS and HEDI research efforts. And judging from all the publicity SDIO generated after its initial midcourse interception demonstration (the 1984 Army Homing Overlay Experiment), we would expect that the early 1990's ERIS and HEDI test firings would attract a good bit of attention.

But those validation experiments alone will not tell SDIO whether it can build militarily capable interceptors. It is in the advanced technology research where SDIO will find out if the interceptors are actually feasible — that is, whether, low-weight, low-cost, and high-performance interceptors can be produced and be effective against a determined Soviet attack.

SDIO's funding reorientation for FY87 increases the risks associated with the full-scale development decision to be made on these interceptors, it causes an imbalance between the near- and far-term schedules for the missiles, and ultimately it may result in money being wasted in the projects.

We are more concerned, however, over whether this is an example of SDIO rushing toward an early demonstration of its technology at the expense of later building a militarily capable system. In other words, is this an example of the "demonstrate now" movement within the program? Are we going to end up with a flashy experiment at the expense of an operational system?

7. Sensors

SDIO again appears to have reoriented the priorities in its sensors program for FY87 and beyond. Last year, for example, SDI officials noted that the mission of the Boost Surveillance and Tracking System (BSTS) had been given the "less stressing mission" of a "bell ringer" to warn of an attack and pass on preliminary information to the midcourse sensors.

This year BSTS, which is the more mature of the space-based sensor technologies, appears to be assuming a greater surveillance role in the boost phase, providing attack warning and assessment, boost vehicle tracking, target positioning, ASAT warning, nuclear burst detection and data collection.

Last year, the Space Surveillance and Tracking System (SSTS) project was "completely revamped," according to SDI officials. SSTS was to assume a greater tracking role in the midcourse, taking on many of the burdens originally envisioned for BSTS. A "new thrust" was taken in the project's concept development and ground tests. Moreover, SDI officials last year placed heavy emphasis on what they termed a space experiment to be conducted in 1989-90. Called STEP (for Surveillance and Tracking Experiment Program), this experiment would involve a prototype SSTS satellite tracking a post-boost vehicle and midcourse objects. STEP also had a hefty price tag of $600 million.

This year, the SSTS program has been stalled significantly, in

effect. STEP has been cancelled and the entire SSTS program for FY87 has been frozen practically at the FY85 funding level. Moreover the FY88 budget request is 25% less than what was projected the previous year. (It must be noted that SSTS project officials and contractors believed that the SDI Organization recently has been rethinking its budget cuts and may give the project more priority.)

Last year, there appeared to be no consideration given to placing a laser range finder on the experiment of the Airborne Optical Adjunct plane. The AOA's passive infrared sensor can do only angle tracking of warheads and other objects in the late midcourse and early terminal phases. The laser ranger, which would enable AOA to determine range, had been an addition planned for future development of the plane.

This year, SDI officials say they "are considering" putting a laser range finder on the experiment, which would give the system a range-finding capability sooner.

Taken together, what do these reorientations indicate? If a near-term deployment were initiated, it would likely have little if any midcourse discrimination capability. What target acquisition and tracking that occurred would be largely in the boost and terminal phases. Indeed, with the scaling back of SSTS it appears that SDIO is shelving for the moment the midcourse discrimination mission. At the same time, it appears to be beefing up the role of the boost and terminal phase sensors (BSTS and AOA), whose technologies are more mature than SSTS. In other words, the sensor technology appears to be reoriented to optimize a near-term deployment.

8. Space-based Kinetic Kill Vehicles

As noted before, the deployment of directed energy weapons is a far-term option for SDIO, likely not to occur before the end of the century. For that reason SDI officials envisioned deploying initially space-based rockets or kinetic kill vehicles, which would destroy Soviet missiles in the boost phase, post-boost vehicles in the post-boost phase, and warheads in the midcourse phase.

Space-based kinetic kill vehicles (SBKKVs) represent the most mature boost intercept technology on SDI drawing boards. The technology, however, has a number of operational limitations, which will be discussed later and would likely have a short life span in space in terms of military utility. Nevertheless, SDIO envisioned SBKKVs as the first wave of weapons in space for its comprehensive area defense, recognizing that as the Soviets developed countermeasures the military utility of these weapons would degrade.

We will discuss later the overall battle architecture in which these SBKKVs would be deployed. For the moment, it should be noted that to achieve a 95% or more effectiveness for the entire system various architectures SDI has been analyzing call for a massive deployment of anywhere from SBKKV battle stations placed in space that would house interceptor rockets.

Up until winter 1986, SDI was conducting ground experiments and defining systems concepts to pursue this robust deployment of SBKKVs for the initial comprehensive architecture. However, in December 1986, according to GAO investigators who had been reviewing the project, Lt.Gen. Abrahamson directed that SBKKV research be drastically reoriented. Instead of pursuing the robust 95% effective system, Abrahamson ordered that the effort be divided into two projects: one to deploy a partially effective system in the near term, and the other to continue pursuing the robust system. The funding allocation for these two efforts in FY87 is decidedly unbalanced, however, and clearly shows that the SBKKV project is now oriented predominantly to a near-term deployment. Of the $75 million budgeted for the SBKKV experiment in FY87, only $5 million has been allocated to research into the robust system. The other $70 million will go toward the near-term option.

In a robust system the SBKKV's would be used for boost, post-boost and midcourse defense and would have an initial operational capability in the mid to late 1990's. In the near-term option SDIO is now pursuing, SBKKV's would have no midcourse capability and would only be able to knock out a small percentage of the Soviet warheads in the boost and post-boost phases. An engineering development decision would be made around 1990 and an initial operational capability would be pushed up to 1993. In addition, the near-term SBKKV's are envisioned to have a life in space instead of a life.

Instead of the President's vision of eliminating the threat of nuclear ballistic missiles, the near-term goal for 1994-95 would be to have a system that does little more than confuse Soviet strategic planning. The Phase II System Concept Requirement SDIO sent out to contractors in February for SBKKV's calls for it to kill only Soviet warheads, allowing over to slip through by Air Force Space Division estimates. In other words, the near-term requirement SDIO sent to its contractors is for a SBKKV system that kills about of the Soviet strategic warheads. Given the overabundance of Soviet warheads relative to useful targets, an kill rate by SBKKV's can only be regarded as a token defense.

Furthermore, the testing schedule for the SBKKV has been changed. The director of the Kinetic Energy Weapons Program said that in 1985 SBKKV's interceptor experiment was to be a full-functional, space-based test scheduled for Since then, however, the scope of the test has been reduced and the date for the experiment has been moved

The recent funding pattern for the entire SBKKV Systems Project also is noteworthy. For FY1987, Congress appropriated a 16% funding increase over FY1986 for SDI activities overall. Yet in allocating that increase, the SDI Organization last October actually cut the SBKKV Project by 5% from its FY1986 funding level. Then last December the decision was made to reorient in effect the SBKKV Project toward a near-term deployment. When the 100th Congress convened in January 1987, the Defense Department requested an emergency FY1987 supplemental appropriation for the SBKKV Project that would increase its budget 22% over the FY1986 level. What is more, the FY1988 SBKKV

budget request is for 87% more than the FY1987 level, augmented by the supplemental.

This funding pattern suggests that the SBKKV Project was not doing too well in the competition for SDI dollars, until the decision was made for near-term deployment. Thereafter, the program turned on a dime. We should note that Air Force Space Division briefers insisted that the initial funding cut in SBKKV was due to the transfer of an activity out of the project. Our briefing in Washington by the KEW Program manager, however, substantiates the conclusion that the program was saved from a cut and boosted by the push for near-term deployment.

The shifting priorities of the SBKKV project represents the most conspicuous example of the programatic reorientation the Strategic Defense Initiative has undertaken to pursue a near-term deployment. Instead of eliminating the threat of Soviet ICBM and SLBM re-entry vehicles, SDIO is settling in the near term for only a token space defense against these warheads. Building simply that token defense will be no small achievement, as will be discussed later. Next, we will consider the reorientation that is being undertaken to put this token system in space in the near-term.

9. Heavy Lift Launch Vehicle

Since its inception, the SDI Organization has realized that it would need to develop a much greater launch capability at radically reduced costs to put the 20 million to 200 million pounds of SDI hardware into space. Keep in mind, in 1985, the U.S. launched a total of about 350,000 pounds, a figure typical of earlier years. Last year, SDI officials emphasized that developing the launch capacity to meet SDI's goals would be a monumental undertaking requiring a "complete revolution" in America's current space effort. However, as huge as this undertaking would be, SDIO in the past has believed that a concerted effort to improve the launch capacity could be put off until even more monumental problems of actually producing the strategic defense components were resolved.

SDIO's attitude toward space transportation has now changed dramatically, however. And clearly the change is due to the movement within the program toward a near-term deployment.

Because of the near-term deployment push, SDI now appears to be shoving money into its space transportation program as fast as it can. The organization has requested an urgent supplemental appropriations for FY87 of $110 million for the heavy-lift launch vehicle. For FY88, SDIO is proposing that the space transportation budget grow tenfold over FY87, not counting the FY87 supplemental. Last year SDIO projected that it would need only $169 million for space transportation in FY88. This year it is proposing that $434 million be spent on space transportation.

When SDIO began reorienting its program last year toward early deployment, the biggest and most obvious obstacle it faced was the absence of any space transportation capacity to lift thousands of

SBKKV's into orbit. Moreover, no space transportation capacity suitable to the requirements of early deployment was even planned last year.

Figure 18 shows SDIO's 1986 chart on possible space transportation timelines, which was included in our report last year. The space shuttle fleet would be in operation, but even if augmented with another shuttle, would have insufficient capacity and would not meet the cost goals to launch a space-based defense.

Shuttle II, a heavy-lift, follow-on to the space shuttle, could have the capacity to support SDI and perhaps have a low enough cost, but it was not envisioned to be ready for service until nearly 2005, according to Figure 18.

A shuttle-derived vehicle (SDV), built from incremental improvements to space shuttle technology, might be ready in the mid 1990's, but being a derivative of the shuttle its cost to orbit would not come close to SDI's goals. (Presently, it costs $1,500 to $3,000 to lift a pound of material into space. SDI's goal is about a 10-fold reduction to $200 to $400 per pound in space.)

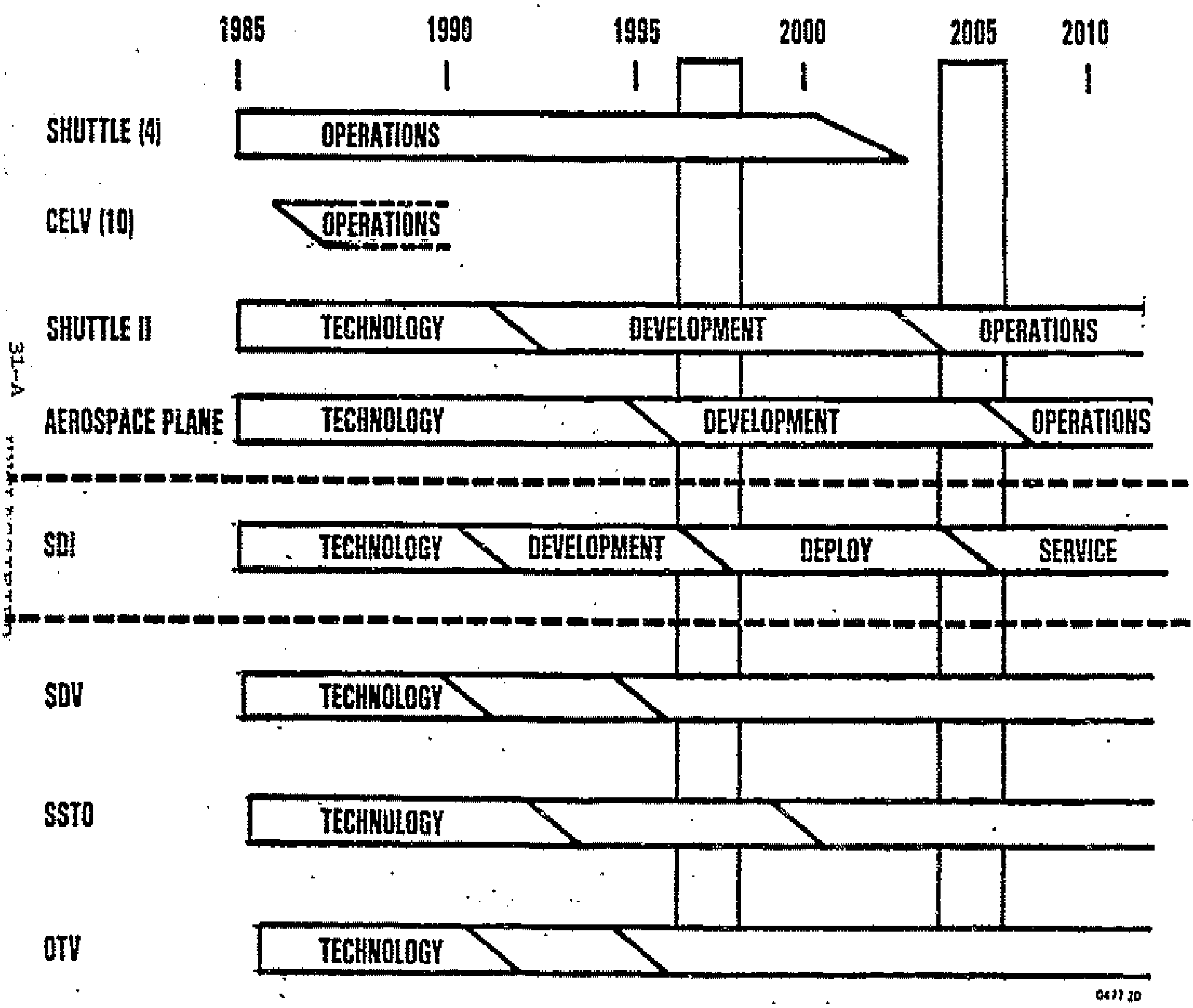
The single-stage-to-orbit (SSTO) vehicle would probably have heavy-lift capability, but again would not be available until the turn of the century.

President Reagan has talked about an "Orient Express," a hypersonic plane that could take off from a U.S. runway, fly passengers into space and land in the Orient. The President also envisioned that this aerospace plane would carry SDI cargoes. Asked about Orient Express's potential for SDI, the program manager in charge of space transportation said this year it would not be ready for any type of heavy-lift transportation in the early 1990's to 2000. "Maybe in the year 2015," he added. "God knows what we can do then."

Last year, however, SDI deployment was not anticipated until the late 1990's because the hoped-for exotic SDI technologies would not likely be available until then. There simply was no anticipated SDI demand for a low-cost, heavy-lift booster before 1995. Furthermore, there was no other military or civilian space program that required such a booster. The space station is designed to be launched by the space shuttle. Briefings by the Air Force Space Division last year and this year indicated no Air Force need in the near term for a heavy-lift rocket with a payload of 100,000 to 150,000 pounds. Last year, the space shuttle, expendable lift vehicles (ELV), and possibly a shuttle-derived vehicle were the launch systems NASA and DoD expected to use in the near term for civilian and military cargoes.

The decision to reorient SDI toward a near-term deployment, however, presented a monumental launch capacity problem. Figure 19 is a draft DoD chart given to Congressional staff, which shows launch requirements the U.S. has, <u>in the absence of a near-term SDI deployment</u>, during the next 20 years. The chart shows that currently the U.S. can launch about 400,000 kilograms annually for that period. The launch requirement for that period, however, will increase to

SDI TRANSPORTATION TIMELINES



31-A

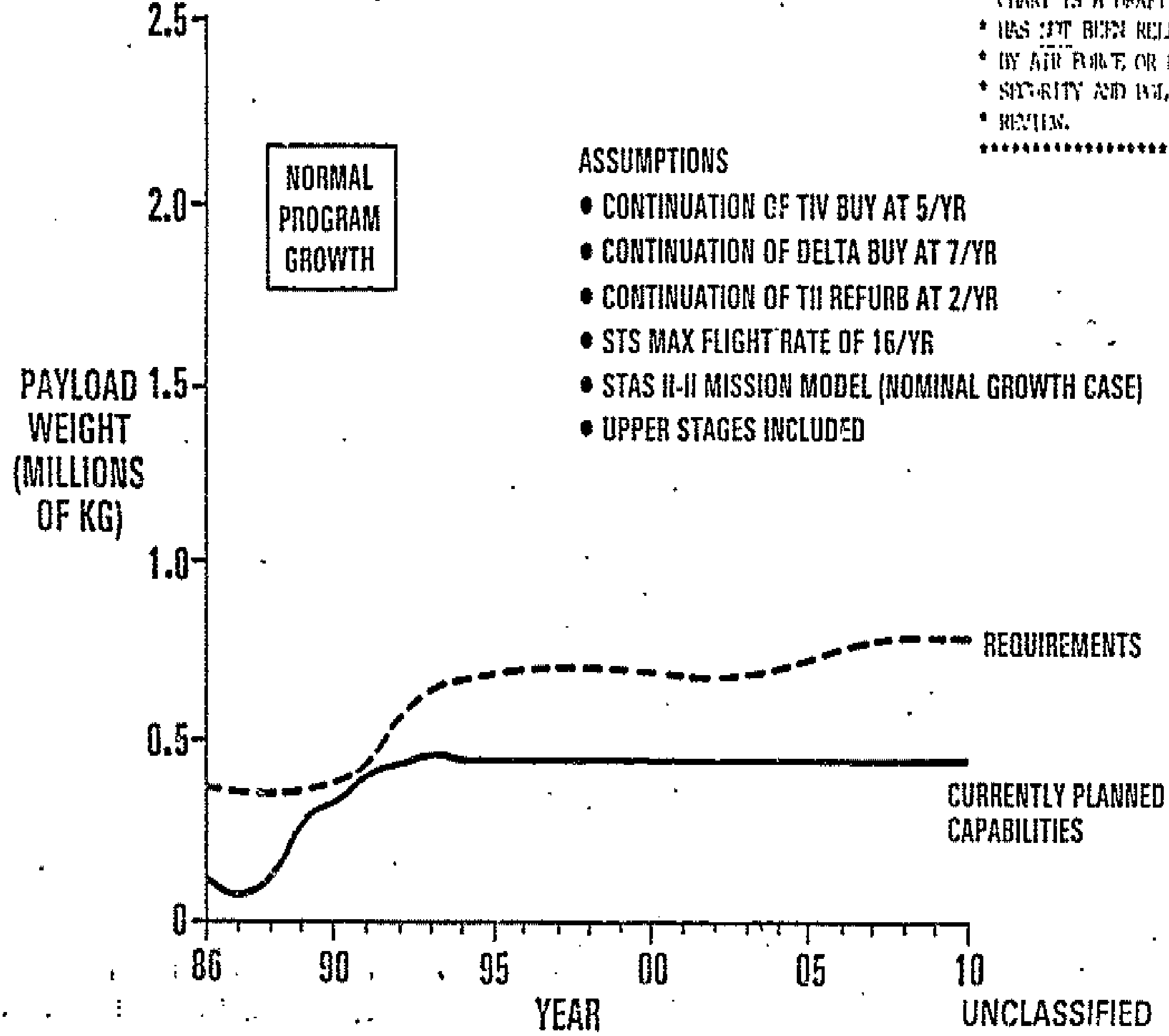
UNCLASSIFIED
Figure 18

UNCLASSIFIED

U.S. SPACE LAUNCH REQUIREMENTS VERSUS CAPABILITIES

52°, 185-KM REFERENCE ORBIT

* PROTECT THIS CHART AS CLASSIFIED INFORMATION. CHART IS A DRAFT AND HAS NOT BEEN RELEASED BY AIR FORCE OR DOD SECURITY AND POLICY REVIEW. *



UNCLASSIFIED

31-B UNCLASSIFIED

UNCLASSIFIED Figure 19

about 750,000 kilograms annually beginning in 1995. Keep in mind, though, that current U.S. capabilities could be increased to meet an annual goal of 750,000 kilograms simply by adding to the U.S. fleet more of the present space vehicles. A heavy-lift launch vehicle is not needed to meet the 750,000-kilogram requirement annually.

Figure 20, however, is a draft DoD chart depicting U.S. launch requirements assuming an early SDI deployment and assuming early production of a heavy-lift launch vehicle. A near-term deployment of SDI causes the launch requirements to skyrocket. Instead of needing to put 750,000 kilograms in space annually beginning in 1995, the U.S. eventually would need to launch about 2 million kilograms, or about 5 million pounds annually.

To lift the tons and tons of space-based kinetic kill vehicles required for an early deployment, the U.S. indeed would have to build some type of heavy-lift launch vehicle (HLLV). A HLLV is envisioned to be able to put 100,000 to 150,000 pounds in space per launch. By comparison, the space shuttle now lifts anywhere from 20,000 to 50,000 pounds depending on the orbit. It is interesting to note, however, that according to Figure C apparently even the HLLV would not be adequate to meet the near-term deployment requirement.

In short, moving to an early SDI deployment would require a new heavy-lift rocket to haul into space the SBKKV hardware. Without an early SDI deployment, no such requirement for a heavy-lift rocket exists in the near term. A HLLV might be useful for other activities, but it is not required that early in the decade.

Figures 21 and 22 are recent draft DoD charts showing what must happen to a heavy-lift rocket program if an early SDI deployment occurred. Figure 21 shows the development of space transportation technology assuming that Congress does not agree to the FY1987 supplemental appropriations request for heavy-lift rocket development and no changes occur in the space transportation system to support an early SDI deployment. The initial launch capability (ILC) of the heavy-lift launch vehicle would not occur until about the year 2000.

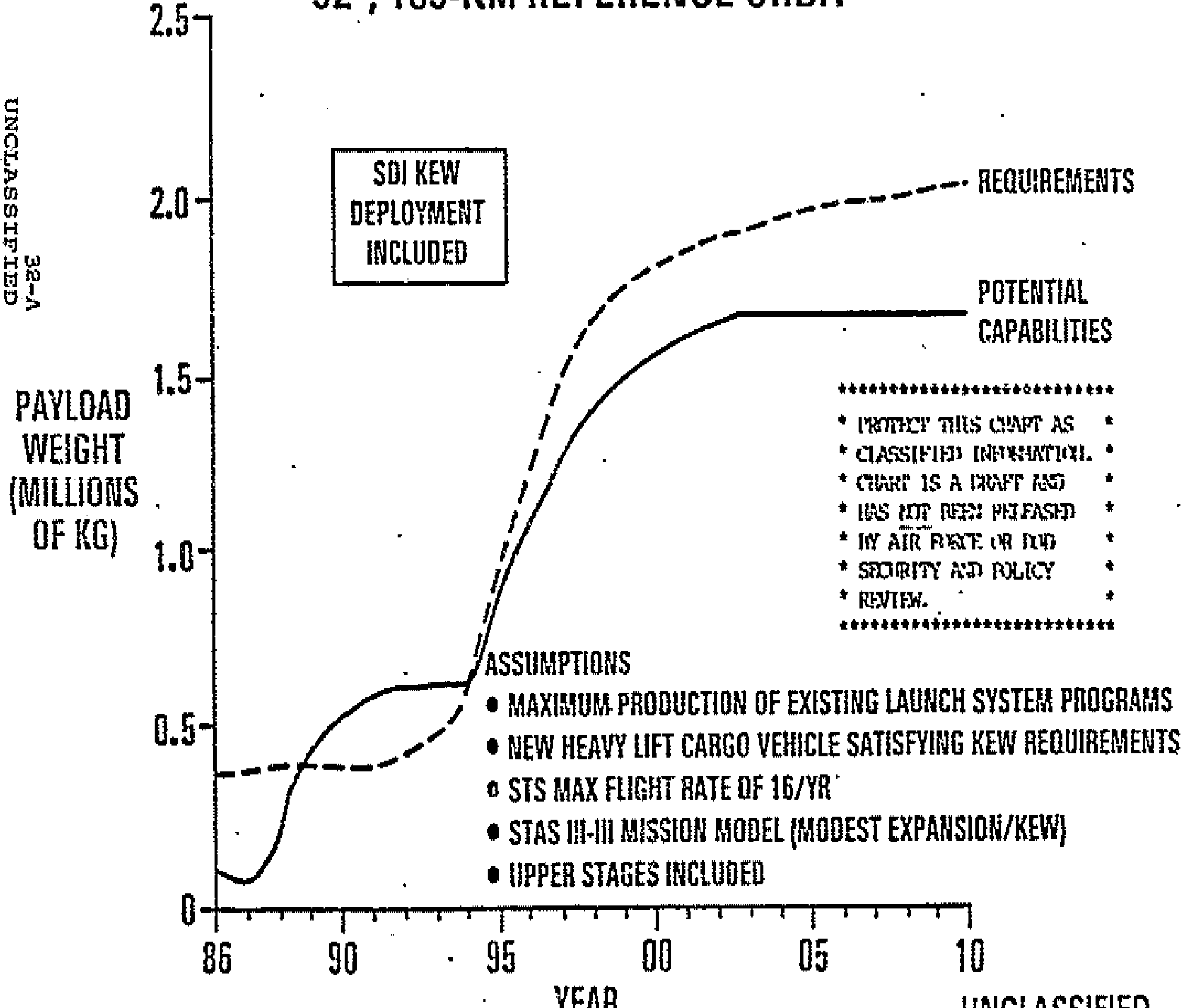
Figure 22 shows what would happen if Congress agrees to accelerate the heavy-lift rocket program. The Defense Department would try to move the initial launch capability of the heavy lift rocket earlier to about 1995, a 4- or 5-year acceleration of the program. On March 5, 1987, in Senate testimony, Air Force and NASA officials confirmed that the Administration seeks an even greater acceleration of the HLLV program, to a 1992 or 1993 initial launch capability. That would mean design, development, testing, and flight certification of a space transportation system in about five years. The fact is, such an acceleration of the original heavy-lift program is not only difficult, it is also impossible to accomplish if the Air Force still wanted to meet SDI's ultimate cost reduction goal in the 1992-93 timeframe.

SDI's goal was to have a heavy-lift rocket with a factor of 10 reduction in the cost of launching an object to orbit. But as one SDI briefing chart put it, acceleration of the heavy-lift rocket program

UNCLASSIFIED

U.S. SPACE LAUNCH REQUIREMENTS VERSUS CAPABILITIES

52°, 185-KM REFERENCE ORBIT

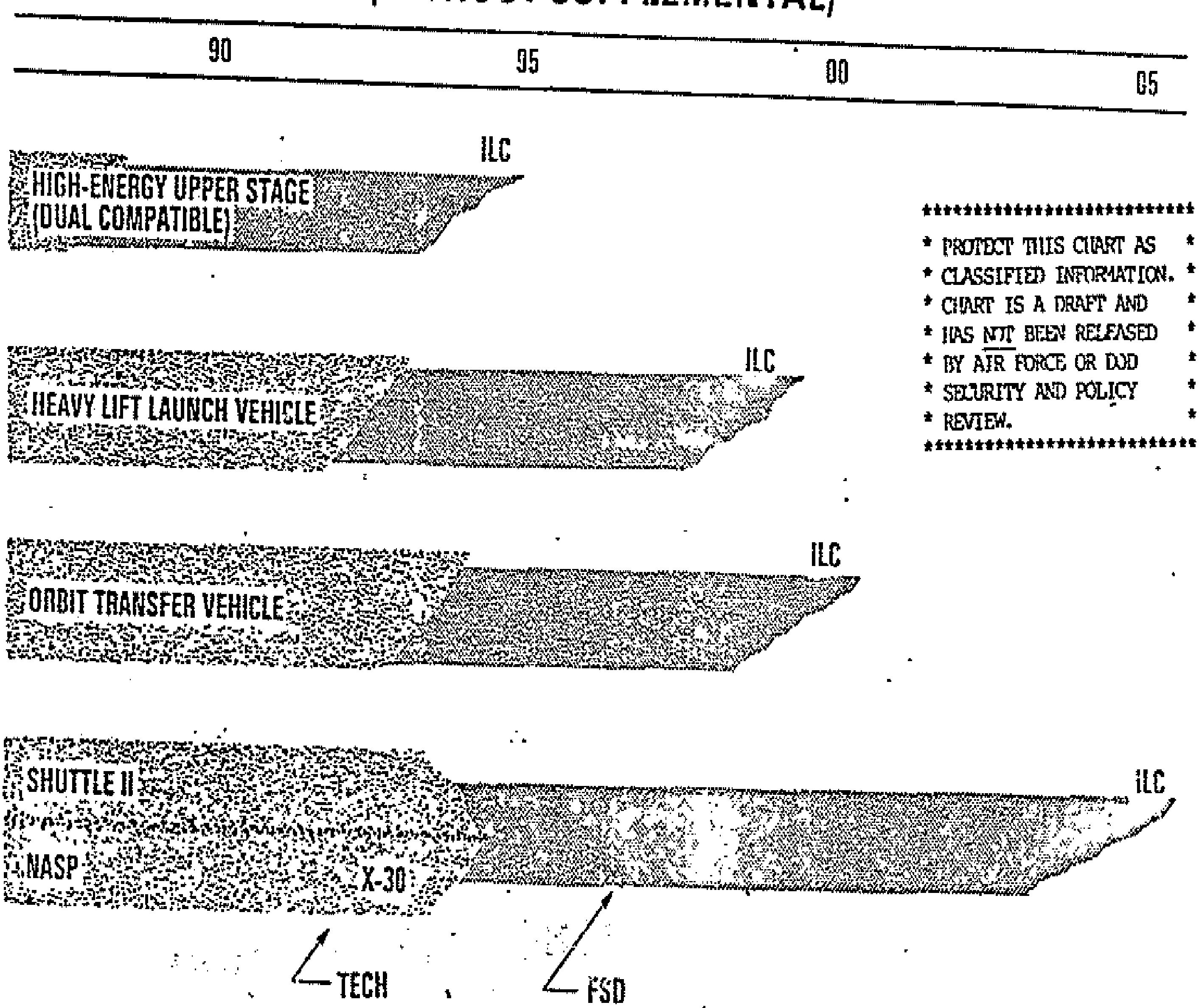


UNCLASSIFIED

UNCLASSIFIED 32-A

UNCLASSIFIED Figure 28

SPACE TRANSPORTATION TECHNOLOGY/ SYSTEM DEVELOPMENT
(WITHOUT SUPPLEMENTAL)



****
* PROTECT THIS CHART AS *
* CLASSIFIED INFORMATION. *
* CHART IS A DRAFT AND *
* HAS NOT BEEN RELEASED *
* BY AIR FORCE OR DOD *
* SECURITY AND POLICY *
* REVIEW. *
****

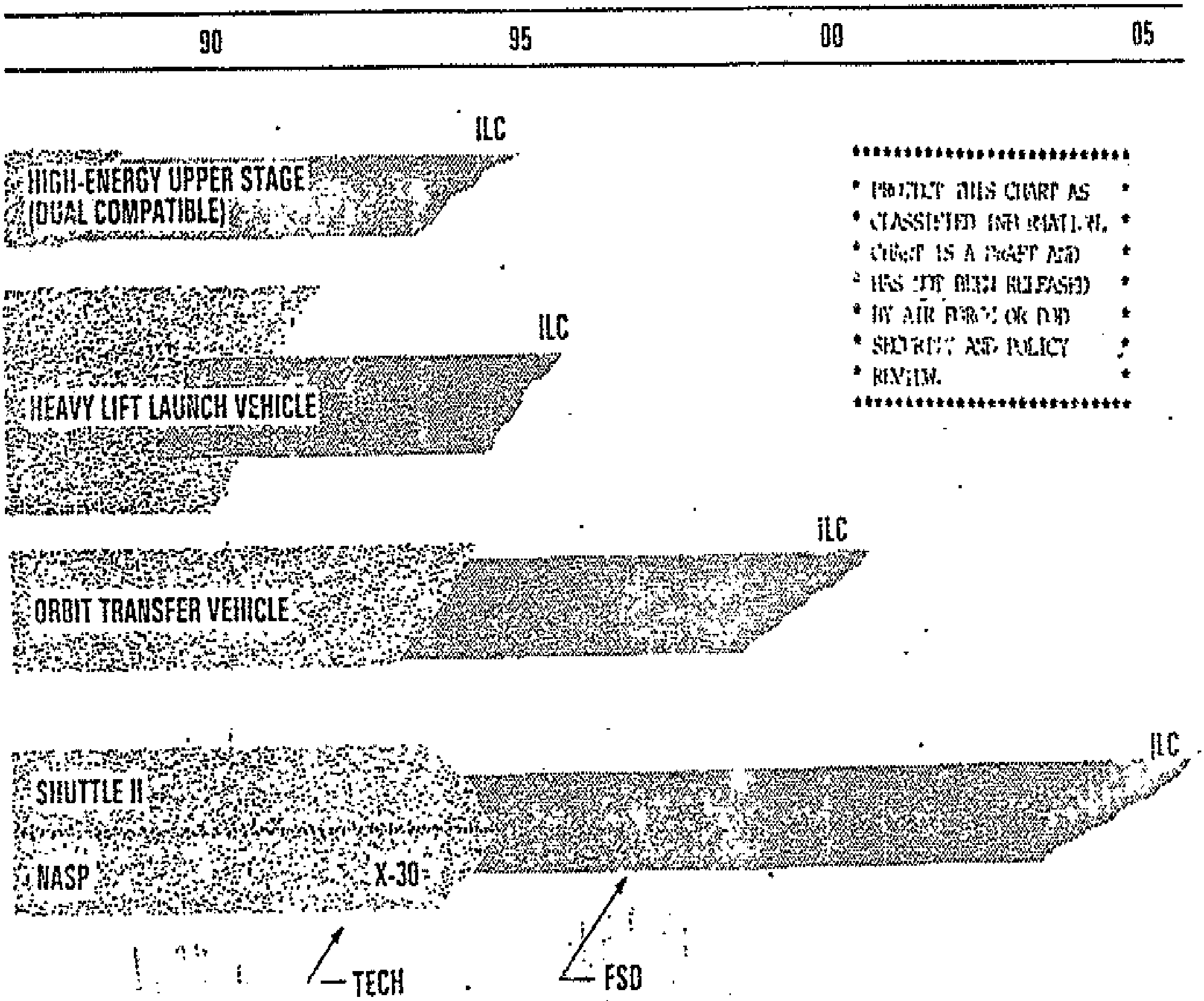
UNCLASSIFIED
Figure 21

32-B UNCLASSIFIED

UNCLASSIFIED

SPACE TRANSPORTATION TECHNOLOGY/ SYSTEM DEVELOPMENT

(WITH SUPPLEMENTAL)



UNCLASSIFIED

32-C UNCLASSIFIED

UNCLASSIFIED
Figure 22

to support an early SDI deployment "precludes incorporating cost reducing technologies" in that near-term rocket. In other words, the technologies envisioned for making an order of magnitude reduction in launch costs cannot be pushed that fast. Congress, no doubt, will recall the predictions NASA officials made about the space shuttle reducing launch costs by an order of magnitude, a prediction that never came to pass. What is more, the space shuttle required 10 years to design and build.

What SDI has done, according to the briefings we received, is tell its rocket engineers to take the design they envisioned for a turn-of-the-century heavy-lift rocket and work backwards to determine what could be done for a near-term heavy-lift rocket. The result is that SDI now is seeking as a goal a near-term heavy-lift vehicle with a factor of 3, not 10, reduction in operating costs. In other words, instead of lifting material into space for $200 to $400 per pound in the far term, SDI is seeking for the 1992-93 timeframe a launch cost of $1,000 per pound.

This near-term, or interim, goal is spelled out explicitly in a draft Program Research and Development Announcement (PRDA) for the heavy-lift launch vehicle design, which we have obtained. A PRDA is a document in which the military solicits design study proposals from contractors. Because of the movement toward a near-term SDI deployment, the Air Force Systems Command now wants a HLLV that lifts material into space for about $1,000 per pound by 1992-93 and $200-$400 per pound by the year 2000. The Air Force draft PRDA states:

> The major criterion will be to select the concept design that comes the closest to the objective HLLV goal of a ten-fold operating cost reduction the earliest and at the lowest development cost. A secondary criterion will be the concept design that comes the closest to the interim HLLV goal of a three-fold operating cost reduction the earliest and at the lowest development cost. The technical, management, and cost proposals will be evaluated at the same time.

An indication of the urgency the Air Force is placing on producing an interim heavy-lift vehicle is the fact that under this draft PRDA the contractors would have only 30 days from the date of the PRDA's publication to respond with a design study proposal for the HLLV.

The difficulty of building a launch system that meets this schedule and its bifurcated cost reduction criteria is not lost on the Air Force. The PDRA states that the interim HLLV should be available, "to the extent that can be done without compromising the ultimate cost reduction objective for the HLLV."

To get a picture of what the Air Force is trying to accomplish, it's like asking Detroit to take its standard American sedan that gets 20 miles per gallon and to create, within half the time normally required for a new vehicle, a new basic design that carries three times as much weight but that has a fuel economy of 60 miles per gallon in the mid-1990's and 200 miles per gallon by the turn of the

century.

It remains to be seen whether such a feat could be accomplished.

C. Near-term Deployment Architecture

No one within the SDI organization would provide us with a systems architecture for what a near-term deployment would look like. That is, no one could or would tell us what would be deployed in the near term, and in what amounts it would be deployed. In fact, our questioning of SDIO officials concerning the existence of a near-term architecture turned up a number of conflicting statements. For example:

• Brig. Gen. Malcom O'Neill, SDIO's deputy director for programs and systems and the person in charge of architecture work, told us he had received no direction from his superiors to put together a near-term architecture and has "made no recommendation on a near-term deployment." "I know what I would do," O'Neill said in reference to a near-term deployment. "But I have no license to recommend that or accomplish it." When asked what stimulated all the talk about near-term deployment, he said, he thought it stemmed from people on Capitol Hill who misunderstood briefings presented by SDI.

We have learned, however, through reliable sources that defense contractors working on SDI's architecture studies have been asked to provide near-term deployment architectures and are in the process of submitting those architectures to O'Neill's office. Further, the contractors are now entering Phase IIC of the architecture horse race in which they are doing considerable work on the near-term option.

• No one would or would provide us with cost estimates for a near-term deployment. After three years in existence, SDIO still has not provided Congress with cost estimates for a far-term, robust deployment, insisting that while it knows deployment can be accomplished the research is nevertheless at too early a stage to determine what it will cost. SDI officials now say that while they know they can begin a near-term deployment within years, they claim it is still too early to tell how much that deployment would cost. The obvious question arises: If the research has so matured that SDI officials are confident of an early deployment in why is the research so immature that a price tag cannot be placed on that deployment?

• During our briefings, no one disputed the fact that only a few SDI technologies would be available for a near-term deployment in the time frame that has been been proposed. In other words, no matter if SDIO did or did not have a near-term architecture laid out, there are only a few types of weapons and sensors it could deploy anyway.

The information that has come to our attention in this study leads us to believe that a near-term reference architecture does exist, despite SDI officials' statements to the contrary. Furthermore, that near-term architecture is not being disclosed to most members of Congress. Additionally, it is our understanding that

this near-term reference architecture is being kept from many scientists within the SDI program.

We understand that SDIO presently has a "black program" that is developing a reference architecture for a near-term deployment of strategic defenses. That is, access to this near-term architecture program is compartmentalized so that only a few members of the House and Senate would be allowed to review it upon request.

We, of course, did not have access to the near-term architecture being developed under this black program. We have been told, however, that the architecture being developed in this black program at full operational capability (FOC) in the late 1990's resembles the public architecture being presented in the December 15, 1986, Marshall Institute report on "Deployment of Missile Defenses in the 1990's."

Furthermore, we have been told that the near-term architecture being considered in the black program is fairly immature and requires further analysis and refinement. As one source told us, the near-term architecture could "not stand any close scrutiny. That's why they've put it in the black." Incidentally, many SDI scientist and program officials also made derisive comments to us about the Marshall Institute report because of its inflated projections of system effectiveness.

Although we did not have access to SDIO's near-term reference architecture, based on our review of the current SDI program, of the changes made in its priorities, and of the near-term options SDI officials have recently received from their architecture contractors, we believe we can describe what kind of near-term architecture SDIO has in mind. In doing so, we will look at four timeframes: 1998 and beyond, 1991-92, 1994-95, and 1997-98.

1. Robust System (1998 and Beyond)

Before examining the near-term architecture, it is useful to note the type of robust strategic defense system SDIO last year envisioned deploying beyond the 1997-98 time frame. This has been known as SDIO's far-term "Reference Architecture," which would supposedly have a effectiveness against ballistic missile warheads. The organization originally envisioned a full-scale engineering development decision on this Reference Architecture sometime around 1993, with the initial deployment beginning about 1997 and full operational capability achieved in the early 21st century.

Figures 23 and 24 present the components of the reference architecture as developed from the studies submitted by the system architecture contractors. As will be obvious from the listing, the reference architecture would involve the deployment of a staggering number of weapons and sensors. Figure 25 depicts in more detail how just the massive deployment of space-based kinetic kill vehicles might be configured. (Figure 25 comes from a reference system concept for SBKKV's developed by the Air Force Space Division. The number of SBKKV's deployed is different from SDIO's reference architecture in Figures 23 and 24. The Air Force concept is one of a number of

architectures that have been presented to SDIO.)

For the boost phase defense, tens of thousands of kinetic kill vehicles would be deployed on thousands of battle stations to try to knock out Soviet boosters, post-boost vehicles and warheads in the midcourse. In [redacted] orbit would be a [redacted] or more BSTS satellites that would serve as bell ringers to warn of an attack. In the midcourse phase, [redacted] SSTS satellites would be deployed, initially perhaps with [redacted] sensors and later with [redacted] to track and discriminate warheads in the midcourse. For the terminal phase defense there would be deployed [redacted] of exoatmospheric interceptors like ERIS, high endoatmospheric interceptors like HEDI, and low endoatmospheric interceptors called LEDI. Also for the terminal and late midcourse phases there would be more than [redacted] Airborne Optical System (AOS) planes with [redacted] plus about [redacted] terminal imaging radars (TIR) based on the ground.

As the Soviets' responsive threat evolved, the midcourse sensors would be supplemented with dozens of DEW space pltaforms that would serve as interactive discriminators.

SDIO envisions that this initial Reference Architecture would be about 95% or more effective against basically the projected Soviet offensive nuclear threat. Keep in mind that this percentage effectiveness represents more of a goal at this point than a proven result. Whatever the initial percentage effectiveness, SDIO realizes full well that it will decrease as the Soviets develop their responsive threat — that is, countermeasures to defeat U.S. defenses. Therefore, as the Soviet responsive threat evolves, SDIO envisions deploying a huge array of DEW weapons and more sophisticated interactive discriminators to keep the effectiveness percentage high. Deployment of these more exotic weapons supposedly would not begin until the end of this century or the beginning of the 21st century.

Now to the near-term architecture. Again, based on our study and discussions within industry, this is the type of deployment scenario we believe SDI is considering. Moreover, the architectures we describe are based on the schedules we have seen for specific SDI systems.

2. Treaty Compliant Deployment at Grand Forks, N.D. (1991-92)

Within the SDI contractor community and the companies performing the systems architecture studies, there is significant discussion about an earlier deployment option than what SDI officials have been publicly implying.

This early deployment option, which would comply with the 1972 ABM Treaty, would involve deploying 100 prototype ERIS interceptors at the old Safeguard Site at Grand Forks, N.D. Lockheed, whose SDI engineers have visited Grand Forks to survey the site, briefed us extensively on this early option.

Presently, Lockheed's ERIS program is building a functional test

vehicle (FTV) that would be flight tested in 1990. This test vehicle would be twice the size of the operational ERIS interceptor SDIO wants Lockheed to eventually produce (see Figure 26), it would be at least six times as expensive as the operational ERIS interceptor, and it would be less capable. Under last year's schedule, SDIO would make a full-scale engineering development decision about 1993, following the FTV tests. ERIS would then have an initial operational capability at about 1998 and a full operational capability by the year 2000-2001.

If a decision were made to deploy 100 missiles, Lockheed would rush up its test schedule for the functional test vehicle and begin renovating the abandoned Safeguard site (see Figure 27). A version of the FTV's would be deployed at Grand Forks by 1992, according to Lockheed, with a capability to destroy 50 Soviet RV's, or less than one percent of its strategic force. For surveillance, tracking, acquisition and kill assessment the site would rely on existing or upgraded ground-based radars (BMEWS, PAR, PAVE PAWS) and satellites (DSP).

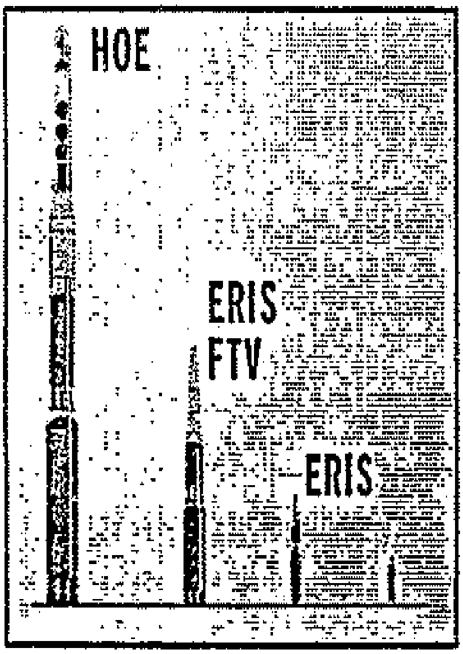
Lockheed officials estimated that the 10-year life cycle cost of a 100-missile deployment would be $3.5 billion. They also maintained that the deployment would protect against an accidental launch or rogue attack, would provide high leverage for the small mobile ICBM deployment, would give U.S. troops operational experience, and would serve as a hedge against a Soviet breakout of the ABM Treaty.

We could not determine whether SDIO is seriously considering a 100-missile deployment. Lockheed officials indicated that additional funds would be required in FY1987 to hold to a 1992 IOC, and so far SDI has not provided that money. Such a deployment would appear to run counter to Secretary Weinberger's objective of initially deploying components "integral" to a far-term area defense. Moreover, scientists in and outside the SDI program have different opinions about the benefits of such a deployment. First, Lockheed's cost estimate at this early date may be low. Furthermore, if the U.S. launched this deployment and what would likely end up being a major construction project at Grand Forks, much of the program's advanced technology progress would be frozen to meet the 100-missile deployment needs. Because of the FTV's limitations, scientists are not in agreement over whether such a deployment could in fact provide complete protection against an accidental launch or rogue missile attack, particularly if the missile came from a submarine. It is generally agreed that this deployment would give U.S. troops operational training Soviet troops now enjoy. Also, it may serve as some hedge against a Soviet breakout of the ABM Treaty, although it is arguable whether this would be the the most effective or efficient hedge.

3. Initial Space-/Ground-Based System Inconsistent With the ABM Treaty (1994-95)

Now we will consider the near-term architecture that SDIO appears to be pursuing for later than 1992. With space-based weapons and interceptors located other than at Grand Forks, this deployment would be inconsistent with the ABM Treaty. It is envisioned that the

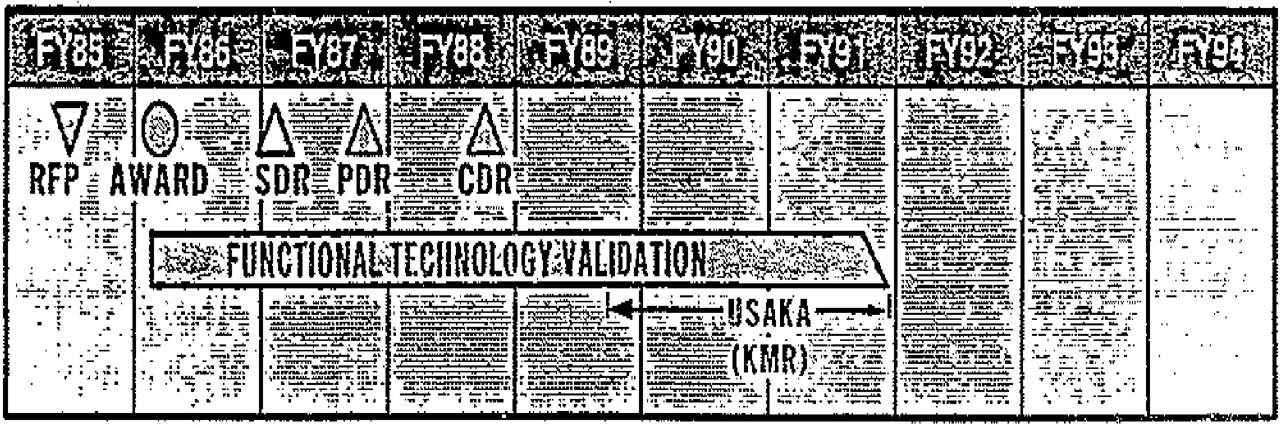
ERIS FTV PROGRAM



CUSTOMER: U.S. ARMY STRATEGIC DEFENSE COMMAND (USASDC)

PURPOSE: DEVELOP TECHNOLOGY FOR VALIDATION OF A LOW-COST, NONNUCLEAR, GROUND-LAUNCHED INTERCEPTOR

PROGRAM VALUE: $ 500M



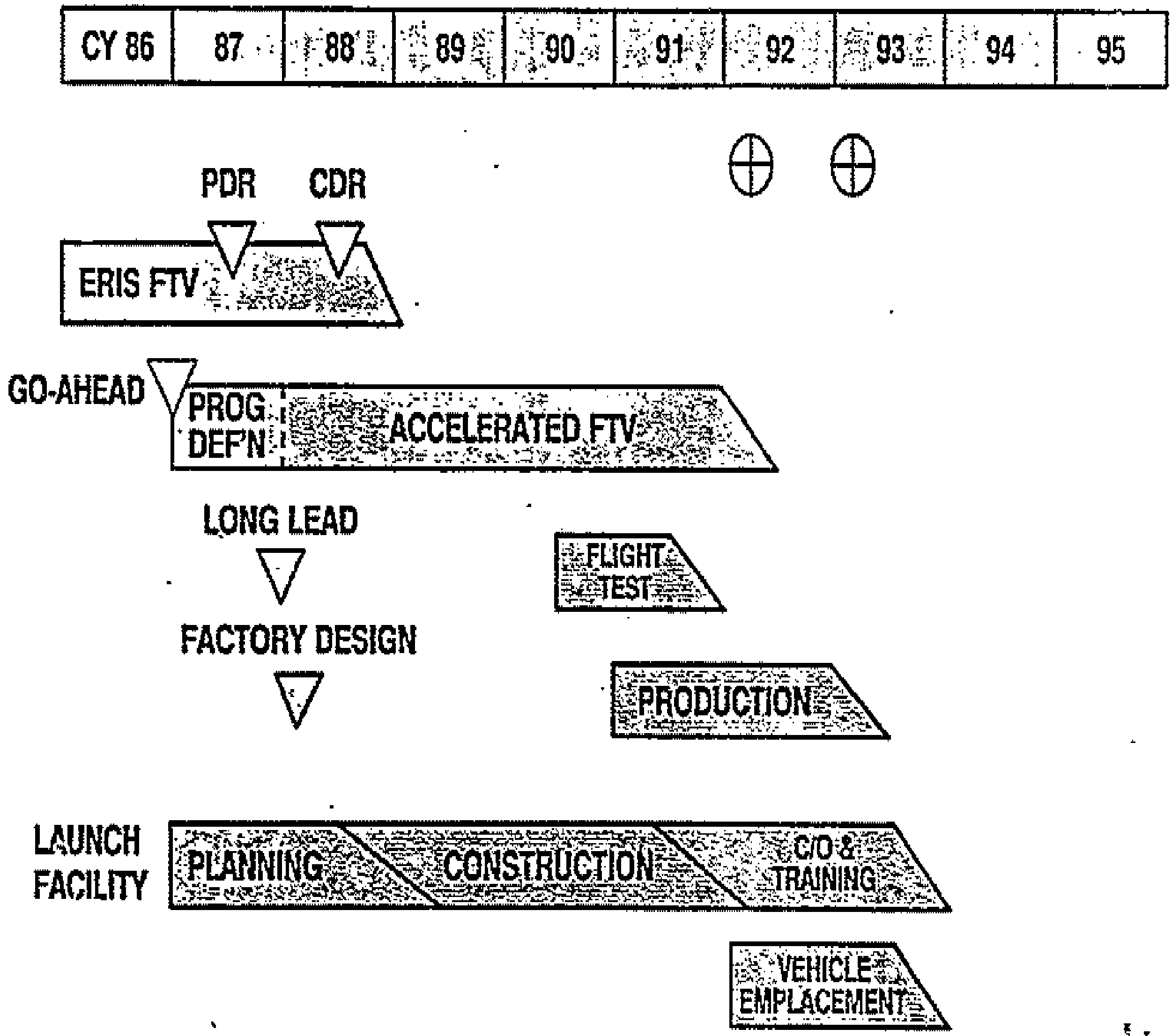
B24.07

Lockheed
12-11-86 P

UNCLASSIFIED
Figure 26

37-A

PROGRAM SCHEDULE



Lockheed

37-B UNCLASSIFIED

Figure 27 UNCLASSIFIED

weapons and sensors that might be available for near-term deployment will reach their major validation milestones in the [redacted] timeframe. Therefore, a full-scale engineering development decision might come around [redacted] according to the optimistic assessment. Then, operating on a tremendously rushed schedule, SDIO might be able to have an initial operational capability of its system by [redacted] We will discuss later the technical and administrative hurdles that must be overcome to meet such a deadline.

In the boost phase, the only weapons technology available is space-based kinetic kill vehicles. As noted before, the SBKKV project managers have directed their contractors to design a system that is capable of killing [redacted] Soviet warheads in the boost or post-boost phase. We will assume, for illustration purposes only, that the Soviet boosters this system would face would have 10 warheads each and no decoys. We will further assume a burn time for the Soviet booster of 300 seconds — about the current capability for an SS-18. With that burn time, we are told that about [redacted] U.S. kinetic kill vehicles in the constellation would be in range of the Soviet target at any time.

Therefore, to kill [redacted] Soviet warheads (or [redacted] Soviet boosters or buses) in the boost and post-boost phases SDIO would need to deploy about [redacted] kinetic kill vehicles in space. Two years ago, SDIO was talking about placing a large number kinetic kill vehicles on each space-based battle station. Now SDIO believes it is better to put fewer KKV's on each platform to lower the value of each platform to an anti-satellite attack. Assume, for example, that about 5 KKV's would be placed on each platform — there would not likely be more than [redacted] If the number is 5, then we are talking about having around [redacted] KKV platforms in space for the near-term architecture in this example.

Keep in mind that the number of KKV's or platforms in space varies, for example, with the number one assigns to the Soviet boosters' burn times and with the probability of kill one assumes for the KKV. Most likely the near-term deployment would have to have more than [redacted] KKV's and [redacted] to kill [redacted] Soviet warheads. Also, the number of KKV's in the constellation would increase as more interceptors are produced and placed in space during this timeframe. (For example, we have seen proposals from system architecture contractors that call for a deployment of up to [redacted] KKV's in 1994-95 — presumably for a higher number of Soviet warhead kills.)

For the moment, however, we will assume that the SBKKV project managers' directions to the contractors to achieve a 1,000-wahead kill goal is, in fact, the goal SDIO has in mind at least for [redacted] If that is the case, then the boost phase would be able to thin out no more than [redacted] of the Soviet offensive nuclear threat.

Only a limited number of sensors could be deployed in this near-term architecture for the boost phase. [redacted] (Full coverage was variously estimated as requiring [redacted] satellites.) [redacted]

The some 20 minutes of the midcourse phase would, in effect, be the blind spot of this near-term architecture. The SSTS, the passive IR satellite for the midcourse, would not be available for this near-term architecture. In other words, unless perhaps Prometheus comes on line early there will be no midcourse discrimination until late midcourse. The KKV platforms also would not be executing any midcourse kills.

The late midcourse would likely have only several to a half dozen airborne optical adjunct planes discriminating and tracking warheads. If AOA is not full strength at that time, SDIO might be able to deploy several dozen rocket-launched probes with infrared sensors to perform some of the tracking and discrimination.

The only ground-based interceptor that could be deployed in the near-term would be ERIS to kill warheads in the late midcourse. (HEDI would not be available in this time frame.) Lockheed projects that beginning in it can deploy ERIS interceptors if it adopts a "hurry-up" schedule of development and production. Lockheed further projects a deployment of up to one dozen ground-based terminal imaging radars for warhead tracking and discrimination in the terminal and late midcourse phases.

Depending on the size of the deployment, Lockheed projects that ERIS could intercept Soviet warheads, or no more than about of the RV's that escaped boost-phase kill.

All told, a near-term deployment in the 1994-95 timeframe would have an effectiveness against Soviet ballistic missile warheads of no more than using Air Force Space Division threat projections. Such a defense, according to one SDI scientist who briefed us, would complicate Soviet strike plans and prevent a "cheap victory," but it would not be very effective in terms of supporting enhanced national security.

Cost estimates for this deployment are even more up in the air. The SDI scientist offered a guess of $15-20 billion for a deployment in that period.

4. Full Near-Term Deployment Inconsistent With the ABM Treaty (1997-98)

Figures for what the near-term deployment would look like in this timeframe are even more tenuous — and, we might add, unreliable.

In the boost-phase, there would be space-based kinetic kill vehicles, many of them upgraded from the 1993-94 models. Anywhere from BSTS satellites would be deployed, depending on the analysis.

In the midcourse phase, a half dozen or more SSTS satellites might be deployed, augmented by satellites. The ERIS force would be increased and upgraded to . Also aiding in midcourse discrimination and tracking would be Airborne

Optical Adjunct Systems and up to probes.

In the terminal phase, HEDI interceptors would be deployed, LEDI (low-endoatmospheric interceptors) would come on line, plus about a dozen terminal imaging radars. Again, these numbers vary depending on the analysis.

How effective would such a system be against the projected Soviet threat? We heard numbers ranging from 30% to eventually 90% depending on the level of deployment, capability, and assumptions.

How much would such a system cost? The estimates fluctuate wildly from $40 billion to $500 billion.

V. NEAR-TERM TECHNICAL HURDLES

Overlooked in the current public discussion over near-term deployment is the question: Can it even be done? The prevailing assumption, which is enthusiastically promoted by the SDI Organization and SDI proponents, is that yes, strategic defenses can be deployed in the near term. The only hurdle remaining is the political will to do so. The only issue remaining is how soon near-term defenses can be erected.

Our review of the technology that would be involved in a near-term deployment leads us to conclude that this is a dangerous assumption to make. Certainly no major breakthroughs in physics are required for a near-term deployment, and the technology involved generally is the most mature that SDI is pursuing. Nevertheless, the technological hurdles SDI faces in pursuing a near-term deployment are considerable and should not be taken lightly. The bottom line is that even a near-term strategic defense will not be easy to accomplish — certainly not as easy as SDI's more avid proponents have forecast.

Keep in mind that the near-term hurdles we are talking about are the ones involved with a system SDIO envisions being deployed in the 1994 and beyond timeframe. None of the timelines we were shown for weapons and sensors indicated that a deployment of nationwide SDI defenses is possible before that time. Clearly a crude, very limited system, such as the 100-missile deployment Lockheed proposed, would face lesser hurdles and consequently could be deployed earlier But such a system is not what Secretary Weinberger has said he had in mind for the near-term. To get an idea of the difficulties with deploying a near-term system beginning in which would be "integral" to a later area defense, we will look briefly at three weapons that would be used in such a defense.

A. Space-Based Kinetic Kill Vehicles

The most stressing hurdles for a near-term deployment will likely be in building the space-based battle stations and their rockets that will attack Soviet missiles in the boost phase.

The SDI program has made significant advances so far in its Space-Based Kinetic Kill Vehicle (SBKKV) Project. In the recently completed Phase I of the project, SDIO, for example, succeeded in defining a concept for what a constellation of SBKKV's might look like (although this concept is being reoriented significantly to accommodate the near-term objective). The project was able to define the type of experiments it wants to conduct to prove the system's feasibility. Also, some preliminary technology validation experiments were conducted in propulsion and interceptor electronics. The project, however, still has a long way to go before an operational SBKKV is produced. To use a football analogy, it's like a team having a successful draft and a good first week of spring training. It's still a long way to the Super Bowl.

In the second phase, project managers will try to validate the concepts they defined in the first phase. They will attempt to build

portions of the the SBKKV battle station and rockets. Then they will try to demonstrate that they can build the entire system by examining and testing its various parts. The second phase will culminate with a test of just the rocket interceptor technology by 1989-1990. All the while, the project will be further refining its concept of how the entire defense system of SBKKV's should be produced and deployed.

Phase II will hardly be a trivial undertaking. A number of critical issues remain to be resolved before an operational SBKKV could ever be deployed, some of which we will now describe:

1. SBKKV contractors and project managers agree that the biggest hurdle they face is the "end game" — that is, building the high speed, highly accurate, and highly reliable interceptor to destroy Soviet missiles. The critical questions being asked, particularly in Phase II of the research, are can a kill vehicle be built that can engage with a high closing velocity and with a high degree of reliability?

The interceptor will have to employ a fairly sophisticated focal plane array sensor to permit discrimination between the Soviet missile and the large hot plume trailing it (the interceptor wants to hit the missile not the plume). SDIO has made significant progress in developing a way to pick out the rocket from the plume. However, it still has a way to go toward mastering this task, particularly with the rapid closing velocities the sensor will face.

Furthermore, the kill vehicle's guidance, navigation and control system will be under tremendous stress in the last few seconds before intercept as it tries to adjust its flight path to hit the missile. "When you're closing at extremely high velocities, there's a lot you have to do in those last few seconds," one briefer told us.

SDIO's project managers and contractors stressed that developing a finely tuned sensing and tracking capability on the interceptor and aboard the battle station will be crucial to the SBKKV's success. Without it, said one contractor, "You could run out of fuel looking for the target, or you could send an interceptor out on a false errand."

In addition to developing the eyes for the system, SDIO also has to improve dramatically the speed of an interceptor. For the test, SDI officials have as a goal a speed of kilometers per second, which may be too optimistic a goal. SDI's ultimate goal is to produce an interceptor capable of travelling much faster.

SDI officials and contractors are confident they can eventually achieve such high speeds. Scientists at the weapons labs, however, are more guarded in their optimism citing "tremendous hurdles" that must be overcome to achieve such high speeds. "A kilometer-per-second KKV requires major advances in propellant, materials and weight design," said one scientist.

The third major hurdle of the endgame is the front-end weight of the interceptor. The weight of the front end — the sensor and the

kill mechanism — determines the weight and to a large extent the performance of the entire interceptor. And the heavier the interceptor, the more the entire battle station weighs, and the more difficult it is to put these platforms in space. SDIO's goal is to reduce the weight of the interceptor's front end to about kilograms, an achievement the Fletcher Panel's report said was necessary "to provide effectiveness and rational orbital weights." Hughes officials predicted it would take about 5 years to get down to kilograms and another 4 years to reach the kilogram goal. SDIO, for example, hopes that the front end weight of its prototype KKV to be tested by 1990 will weigh kilograms or at least no more than kilograms.

2. Hughes contractors believe that building the platform to house the kinetic kill vehicles in space will not be too difficult. The main problem will be making the platforms survivable. The Air Force, in its Phase II system requirements stated that a near-term deployment of SBKKV's must be survivable against anti-satellite weapons, Soviet ground-launched missiles, and ground-based lasers.

No one knows whether the Soviets would employ these countermeasures in the near term. If they did, making the SBKKV's invulnerable to them would be a tall order. The tradeoff becomes one of weight. SDI officials predict that at least 20% of the battle station's weight will have to be devoted to enhancing its survivability. The more survivable the battle station is made — that is, the more hardening, maneuver and shootback capability it has — the more the station will weigh. SDI systems analyses have largely concluded that battle stations with large number of missiles that are also invulnerable to countermeasures would simply weigh too much to launch into space.

For that reason, SDIO is leaning toward battle stations with a fewer number of KKV's, as noted before. And it appears to be opting for "resilience" over "invulnerability" — more lower valued targets instead of invulnerable ones. Therefore, the total weight envisioned for each of these platforms — keep in mind these are very rough estimates — is no more than 3 to 5 tons. Such a platform, if it can be built at that low weight at all, would likely have limited hardening and maneuver capability, according to the experts we consulted. We should note that one analysis at Sandia pitting Soviet ASAT's against SBKKV platforms showed that achieving an "optimal survivability" of requires the mass of the platform to be for hardening, maneuverability and self defense. Such a platform would weigh

3. The final issue to be resolved with SBKKV's is producability. Because tens of thousands of missile interceptors will ultimately be required, they will have to be mass produced at dramatically lower prices than the defense industry is currently capable of producing. SDI contractors point out there have been previous instances of industry moving quickly from handcrafting to mass production of weapons. However, there have been few instances of the defense industry achieving drastic economies of scale in any form of weapons production. For a variety of reasons, many of them not industry's

fault, weapons prices tend to be driven up, not down.

SDI proponents have talked about producing the kinetic kill vehicle interceptors at $100,000 a copy. Achieving such an unusually low price remains to be seen. By way of rough comparison, the Department of Defense has projected that it can build 17,000 advanced medium-range air-to-air missiles (AMRAAM's) for $359,000 per missile — and the General Accounting Office has questioned the accuracy of that projection.

One final note, the SBKKV experiment, whose scope has been scaled back, will not be of a militarily capable system. A three-stage booster will be used to pop up a kinetic kill vehicle that will be fired at a booster. The goal of the experiment is to demonstrate that the "end game" can work — that the missile can be picked out of the plume, that the seeker can home in on the missile in the last few seconds, and that divert and closing velocities can be achieved. Left to be demonstrated is whether SDIO can produce low-cost, reliable, and survivable battle stations that can aim and fire at a moment's notice.

Under a near-term deployment schedule, SDI officials envision the first SBKKV's being placed in space beginning anywhere from

To do so, however, the full-scale engineering development and production period that would normally be expected for such a major new weapons system would have to be significantly compressed, or truncated. Whether that can be accomplished without an unacceptable level of risk remains to be seen.

B. <u>ERIS</u>

The second key weapons element of a near-term defense would be ERIS, the exoatmospheric reentry vehicle interceptor subsystem. ERIS interceptors would destroy Soviet warheads in the late midcourse phase by colliding with them. An initial deployment would number several hundred to several thousand. Over time, however, SDIO envisions

or more ERIS interceptors deployed. At the moment SDIO is leaning toward placing the

that would roam the perimeter of the United States. Lockheed officials predicted, however, that ERIS would eventually end up in fixed sites.

ERIS represents the most mature ground-based interceptor technology on the SDI drawing boards. Already, the Army has tested a very crude prototype model, the 1984 Homing Overlay Experiment, which gave SDI officials some confidence that incoming warheads could be destroyed with non-nuclear interceptors. In fact, SDI officials have gone so far as to claim that HOE demonstrated that strategic defenses work. That is hardly the case.

The HOE was far too heavy for operational purposes. The kill vehicle alone weighed over 1 ton, while an ERIS kill vehicle should weigh about 100 pounds. HOE vehicles cost over $10 million apiece, while SDIO hopes to get the cost of each ERIS down to less than $1 million. HOE had delicate, sensitive instruments that required tremendous precision, while an operational ERIS must have rugged,

reliable instruments with medium precision. Maintaining HOE in an operational state would be a "staggering thought," according to one Lockheed engineer. ERIS must be a quick-launch, easy-to-operate system.

Lockheed is planning to conduct its initial flight tests of an ERIS functional test vehicle in That experiment, whose total cost is estimated to be $794 million, will demonstrate the intercept functions without specific regard to weight, cost, and operational requirements. Much of the technology for the functional test vehicle will involve off-the-shelf hardware that has been essentially repackaged. The technology that would be stressed in this test would be in the seeker, propulsion and ordinance systems. Figure 28 depicts the sequence of events that might occur in the flight test. As complicated as this test will be, SDIO still has a long way to go before it achieves the operational capability it wants for ERIS. What follows are some of the critical hurdles that must be crossed to achieve an operational system:

1. Quick Start, Long Lasting

The Homing Overlay Experiment interceptor took three days to cool its seeker and hand-calibrate its detectors before it could be launched. ERIS must be ready for flight in seconds. Ideally, it would be powered up two seconds before launch. It remains to be seen how quick a response time can be achieved for ERIS. By way of rough comparison, a mobile Pershing II missile takes a total of about minutes to lift off after it has received an alert.

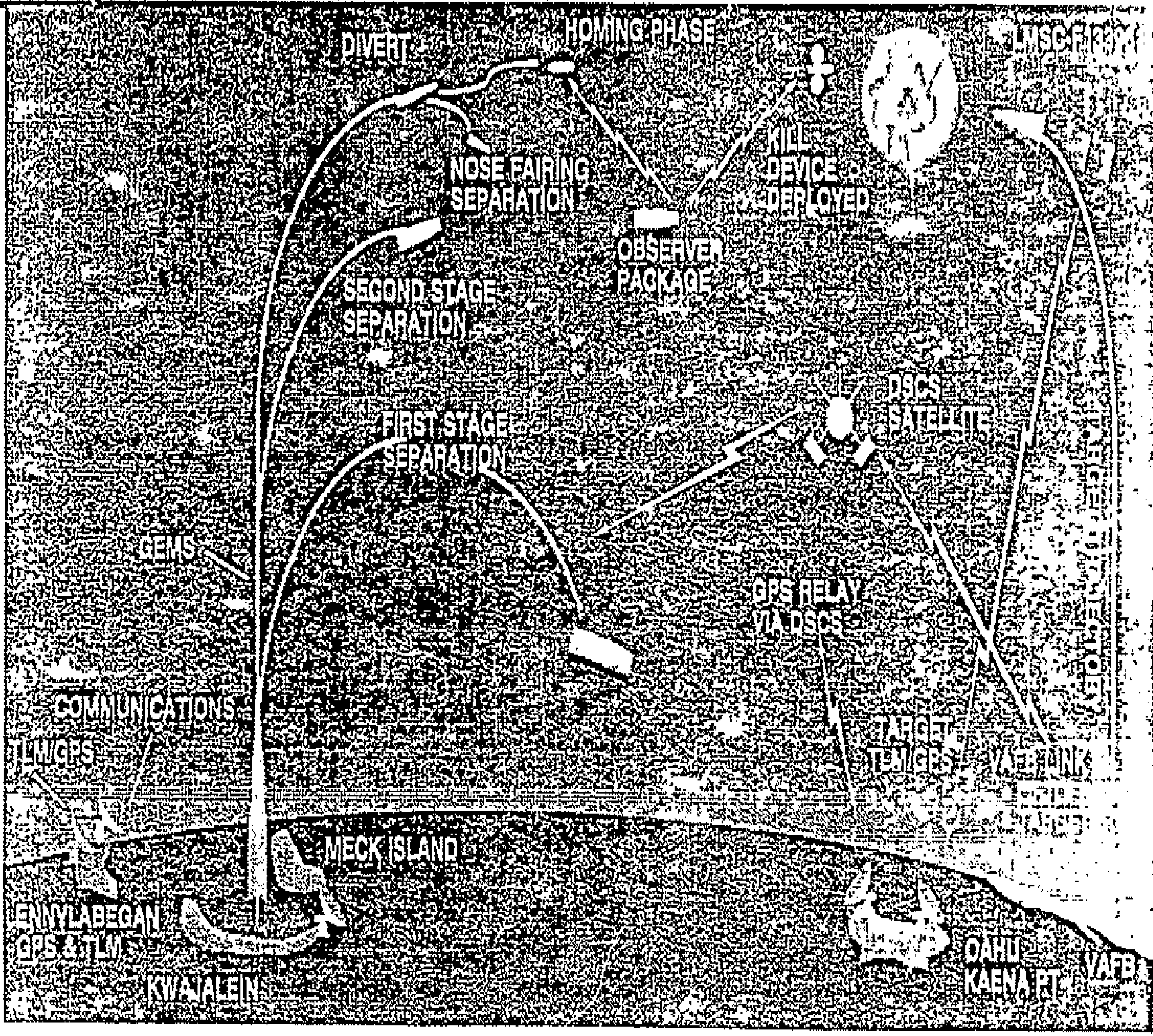
Not only does the ERIS have to be quick starting it also has to be long lasting. SDIO envisions that the missile will have to remain dormant but battle ready for up to ten years, "so the soldier in the field doesn't have to do anything to it," according to a Lockheed official. Whatever recalibration that is done will have to be performed in-flight.

2. Sharp Eyes

Figure 29 depicts the complex sequence of events that occurs from the time between an ERIS launch and its final intercept. As is obvious from the picture, the kill vehicle must perform a number of maneuvers quickly before reaching its target at a closing velocity of miles per second. The flight test will hopefully demonstrate that ERIS can receive target information from an external sensor and process it in short order to engage the target.

Research is still being conducted on how much of a target discrimination capability ERIS can have on board. Lockheed officials note that one way to lower the cost and weight of ERIS is to move the burden of discrimination and pre-commit data to the SSTS and BSTS satellites. Indeed, it appears that the bulk of the discrimination capability will have to be aboard the sensor satellites. As it now stands, however, SSTS's midcourse discrimination capability would not be available for ERIS if it is deployed in the near-term 1994 timeframe. The question of when the Soviets could deploy decoys then

FTV FLIGHT SEQUENCE OF EVENTS



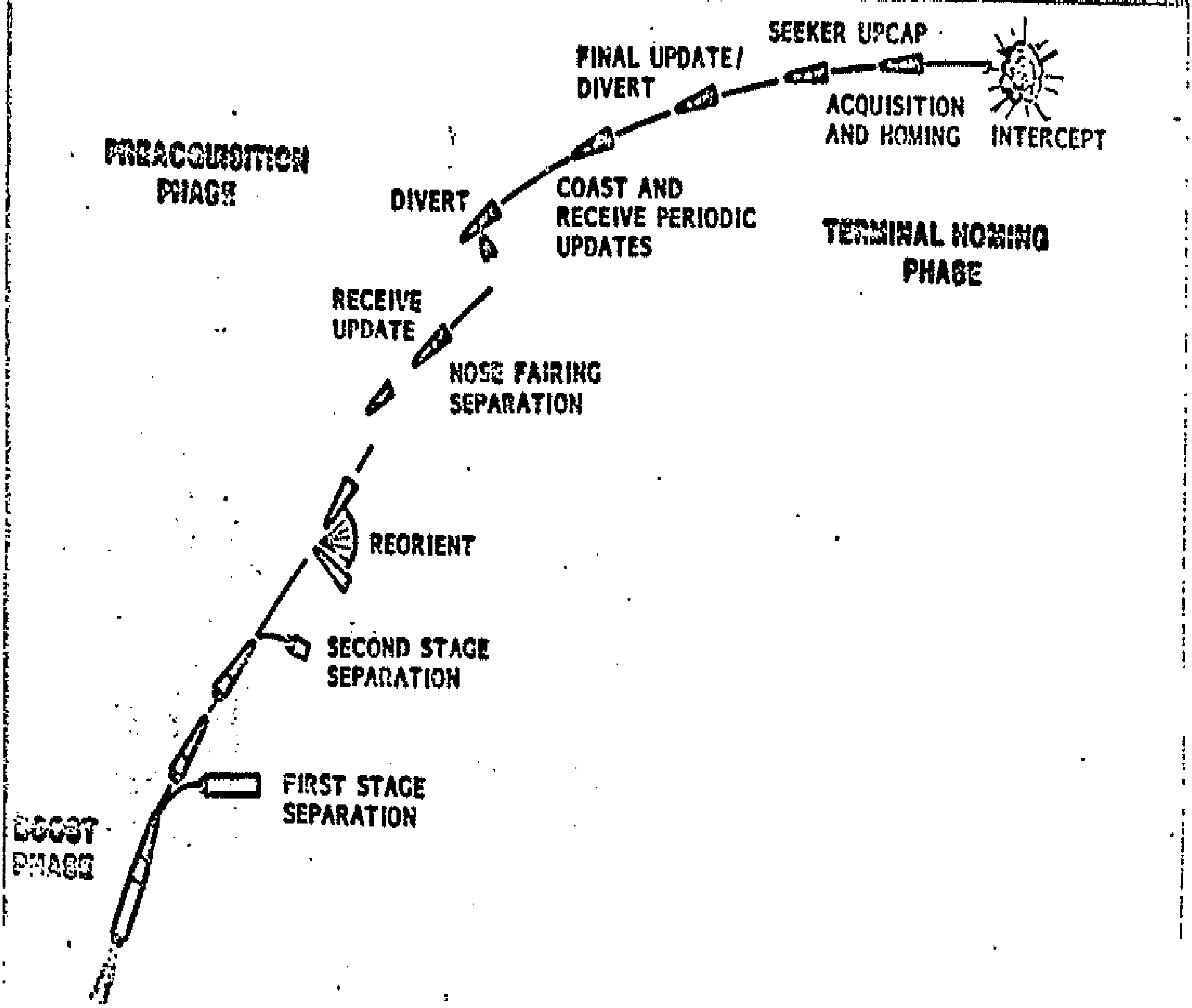
UNCLASSIFIED

LOCKHEED

UNCLASSIFIED

(U) ERIS SEQUENCE OF EVENTS

LMSC-L074399



UNCLASSIFIED

UNCLASSIFIED
Figure 29

becomes crucial. Without a discriminator such as SSTS, "ERIS has a problem" if the Soviets deploy decoys, according to one Lockheed official. There will be no atmosphere to separate decoys from warheads in the midcourse, so ERIS is faced with intercepting everything it sees unless satellite discriminators tell it otherwise.

Mass producing the on-board seekers that will guide ERIS on its last 45 miles of flight will not be an easy task. Simple production designs must be developed for this sophisticated piece of equipment. Techniques involving high-precision, computer-controlled equipment will be needed to manufacture mirrors and infrared detectors in high volumes and at drastically reduced costs. It remains to be seen whether these new manufacturing technoques can be developed.

3. Weight and Costs

The functional test vehicle that will be ready in 1990 will be 33 feet long and weigh 17,000 pounds. The operational ERIS must be substantially smaller -- 14 feet long and pounds in weight. Can ERIS be shrunk to that size and maintain the performance levels envisioned (see Figure 30)? It remains to be seen. The key to achieving it will be reducing the weight of the missile's front end (its kill vehicle). The

pounds (see Figure 31). "It's no mean trick getting to that level," a Lockheed engineer said.

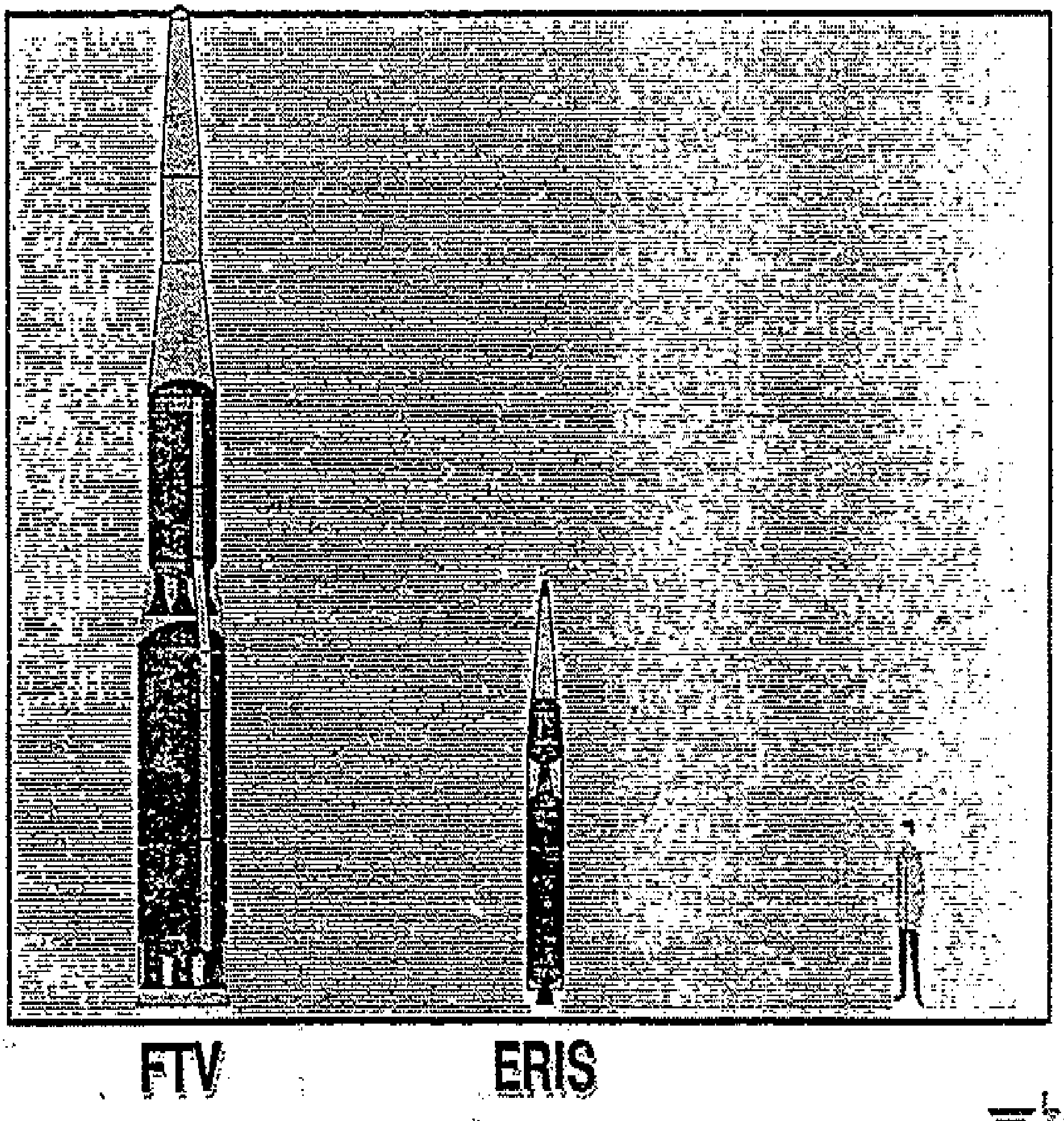
Finally, the toughest hurdle along the path to an operational system is cost. "The real issue with ERIS is to make it cheap," a Lockheed official told us. SDIO has set a goal of $1 million to $2 million in life-cycle costs for the ERIS. In other words, the cost of development, production and 10 years operation should cost no more than $1-2 million per missile. Can such a remarkably inexpensive missile be mass produced? It remains to be seen. The United States has never produced or attempted to produce such a high performance interceptor at such a low price. Lockheed engineers agreed that "life cycle costs will make or break the ERIS concept."

C. HEDI

The terminal phase of a strategic defense has the advantage of not worrying about discriminating warheads from decoys. The atmosphere will separate or burn off the lighter weight decoys leaving the heavier warheads to be destroyed. The disadvantage is time. It takes a minute or less for the warhead to reach its target from the time it reaches the atmosphere.

U.S. anti-ballistic missile research in the past has assumed that nuclear-armed terminal interceptors would defend hardened targets, such as missile silos. The nuclear interceptor would explode when it got near the incoming warhead. Interceptor accuracy and the altitude the interceptor destroyed the warhead was not terribly important. SDI's goal of defending soft targets, such as cities, with non-nuclear interceptors poses a far more difficult task. The interceptor must reach a high altitude in a matter of seconds and practically hit the

ERIS FTV vs. BASELINE AIR VEHICLE



B24.08

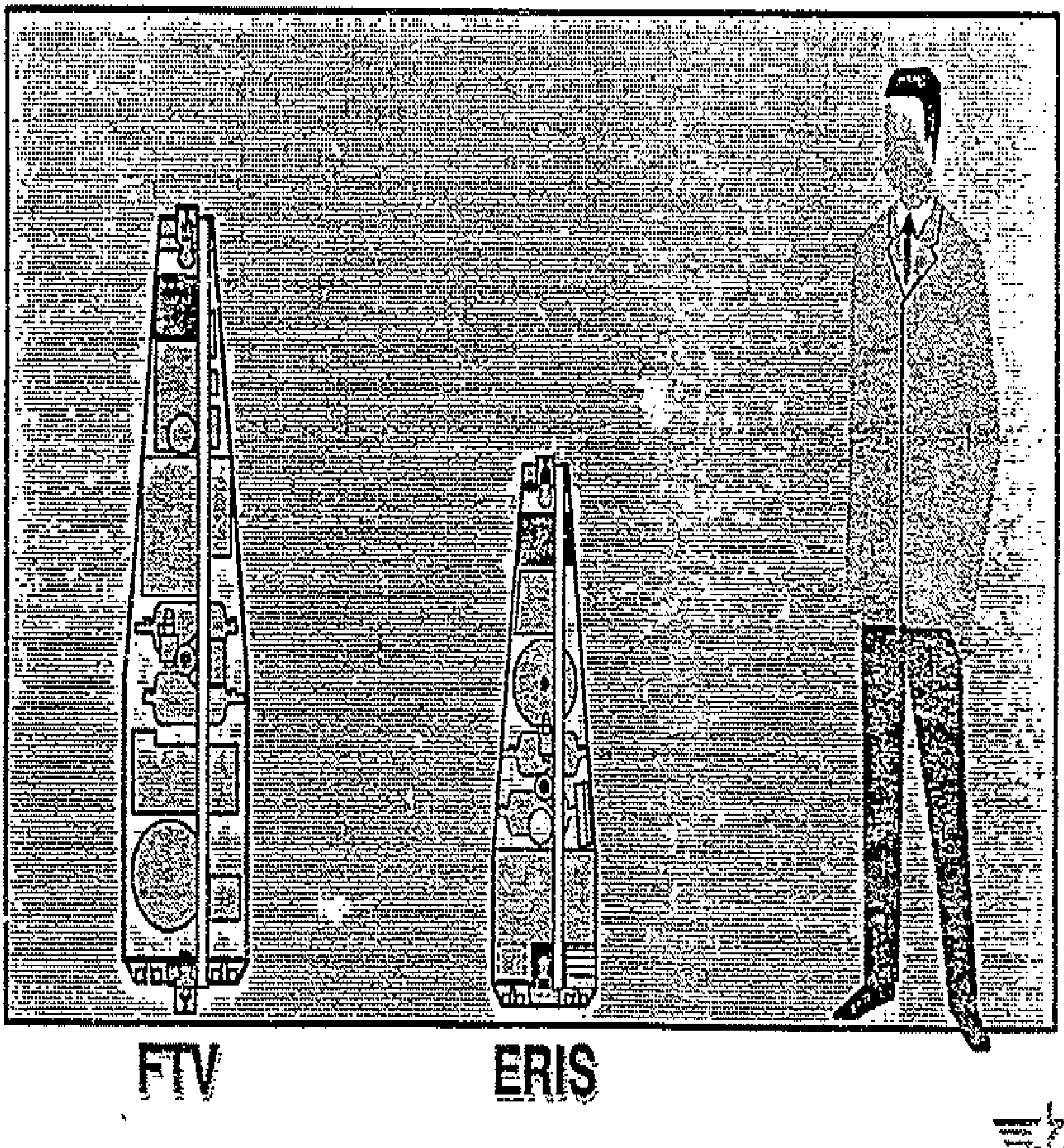
Lockheed
10-12-85 P

Figure 30

UNCLASSIFIED

UNCLASSIFIED

ERIS FTV vs. BASELINE KILL VEHICLE



FTV

ERIS

B24.09

Lockheed

12-11-88 P

Figure 31 UNCLASSIFIED

bull's eye, because the incoming warhead will likely be salvage fuzed to detonate and damage the target even if intercepted. Therefore, the Strategic Defense Initiative is trying to develop a non-nuclear high endoatmospheric defense interceptor (HEDI).

The HEDI program is not as far along as the ERIS program. In fact, while the 1984 Homing Overlay Experiment demonstrated the feasibility of an interceptor destroying a warhead in the midcourse phase, we will not demonstrate the feasibility of destroying that warhead with a non-nuclear interceptor within the atmosphere in the terminal phase until 1989. For that reason, it is unlikely that any HEDI's would be immediately available for a near-term architecture. Most likely, a full-scale engineering development decision would occur in 1992 and an initial deployment would be shortly after the 1995-96 timeframe. It is envisioned that ultimately about | HEDI interceptors would be deployed in hardened silos at about | locations around the country. Ground-based terminal imaging radars (TIR's) would identify and track the warheads for HEDI.

Presently SDI is conducting a two-phased experiment. The first phase will take 5 years and will involve 5 flight tests not against targets. Phase II will conist of 5 flight tests against targets beginning in 1991. The entire experiment is expected to cost about $1 billion.

The critical issues SDIO has to resolve in these experiements are speed, weight, accuracy and quick reaction time.

1. Speed and Weight

The organization's goal is to develop an interceptor | miles per hour. By comparison, a Patriot surface-to-air missile flies at about 3,000 mph. The HEDI flight test vehicle will travel at | mph and be much heavier than the operational version. The test interceptor's kill vehicle, for example, will weigh about | pounds, while the operational kill vehicle should weigh about | pounds. SDI and its contractors believe that they can scale up to the higher performance and down to the lower weight levels required. Yet clearly major technological advances will be needed in the propulsion system and interceptor weight to move from a test vehicle to an operational vehicle.

2. Atmospheric Effects

HEDI's kill vehicle will have a sensor that will be covered by a shroud until about 4 seconds before its intercept, which will occur at an altitude of 40,000 to 150,000 feet. When the shroud is blown off, the on-board sensor has just four seconds to find the warhead and guide the HEDI kill vehicle to it. Not only will the kill vehicle have to operate reliably in an incredibly short period of time, it will also face a tremendous amount of atmospheric turbulence as it hunts for its target.

Keep in mind, the kill vehicle and its seeker will be travelling through the atmosphere at mph. It's like driving a motorcycle with your eyes open with no goggles or glass shield, only worse. Flying at such a high speed causes a number of problems for the seeker. One is "boresight error" which causes the target to appear somewhere other than where it is. The other problem is "image blur" where the high speed causes a distortion of the target image because of varying air pressure and the window material.

Furthermore, most materials will tear apart or melt travelling mph. Therefore, the seeker's window will have to be rigid enough to withstand this stress but not so rigid that it degrades the optical signal passing through it so it can track the target. The seeker's window also will have to be cooled to withstand the extreme heat, but again the cooling must not interfere with the seeker's performance. One other problem: removing the shroud in the last 4 seconds to open up the eyes of the seeker. The shroud separation must be accomplished in a way that does not damage the kill vehicle or knock it off course.

3. Split-Second Interception

The Soviet warhead, when it reaches the atmosphere will be travelling up to 16,000 mph. HEDI's kill vehicle will be travelling mph. In other words, the closing velocity will be mph. The seeker has 4 seconds to home in on its target. HEDI's kill vehicle will have to pass within of the Soviet warhead to destroy it. HEDI's warhead also will have to be fuzed to explode at just the right moment within those so it destroys the Soviet warhead before its nuclear round, which may be salvaged fuzed, has a chance to detonate. Accomplishing all this will be far from a trivial undertaking.

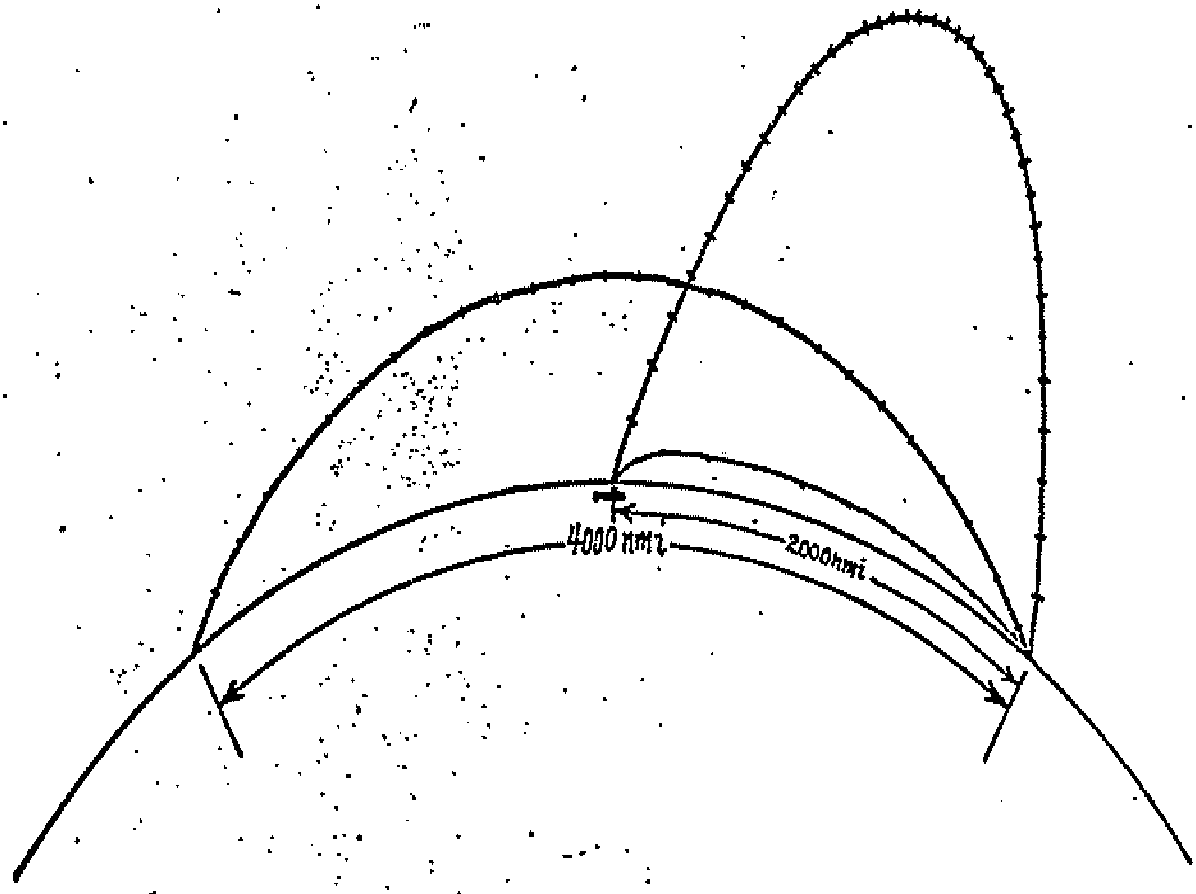
One other note on a Soviet countermeasure that might stress the HEDI defenses. As mentioned before, TIR will be providing tracking and target identification for HEDI. Once the Soviet threat cloud enters the atmosphere, TIR is expected to have an easier time picking out warheads because atmospheric drag will separate the decoys from them. Warheads fired from Soviet ICBMs will enter the U.S. atmosphere at an angle, thus giving TIR extra time to watch the decoys trail off. TIR and the HEDI defense system, however, run into a problem if the Soviets loft their warheads, particularly the ones fired from submarines at close range (see Figure 32).

Lofting enables the warheads and decoys to come in at less of an angle, thus spending less time in the atmosphere. Figure 33 depicts a normal ICBM trajectory and a lofted trajectory. The decoys are represented by dots and the warheads are represented by circles. Both are plotted at one-second intervals. In the normal ICBM trajectory the decoy and warhead travel at about the same speed at 13 seconds before intercept (when the dot is in the circle). After that point, the decoy begins to trail the warhead because of the atmospheric drag effect and TIR can pick up the difference. But in a lofted trajectory the decoy does not begin travelling slower than the warhead until 5 seconds before intercept — a much shorter time for TIR to pick up the

Figure 32

UNCLASSIFIED

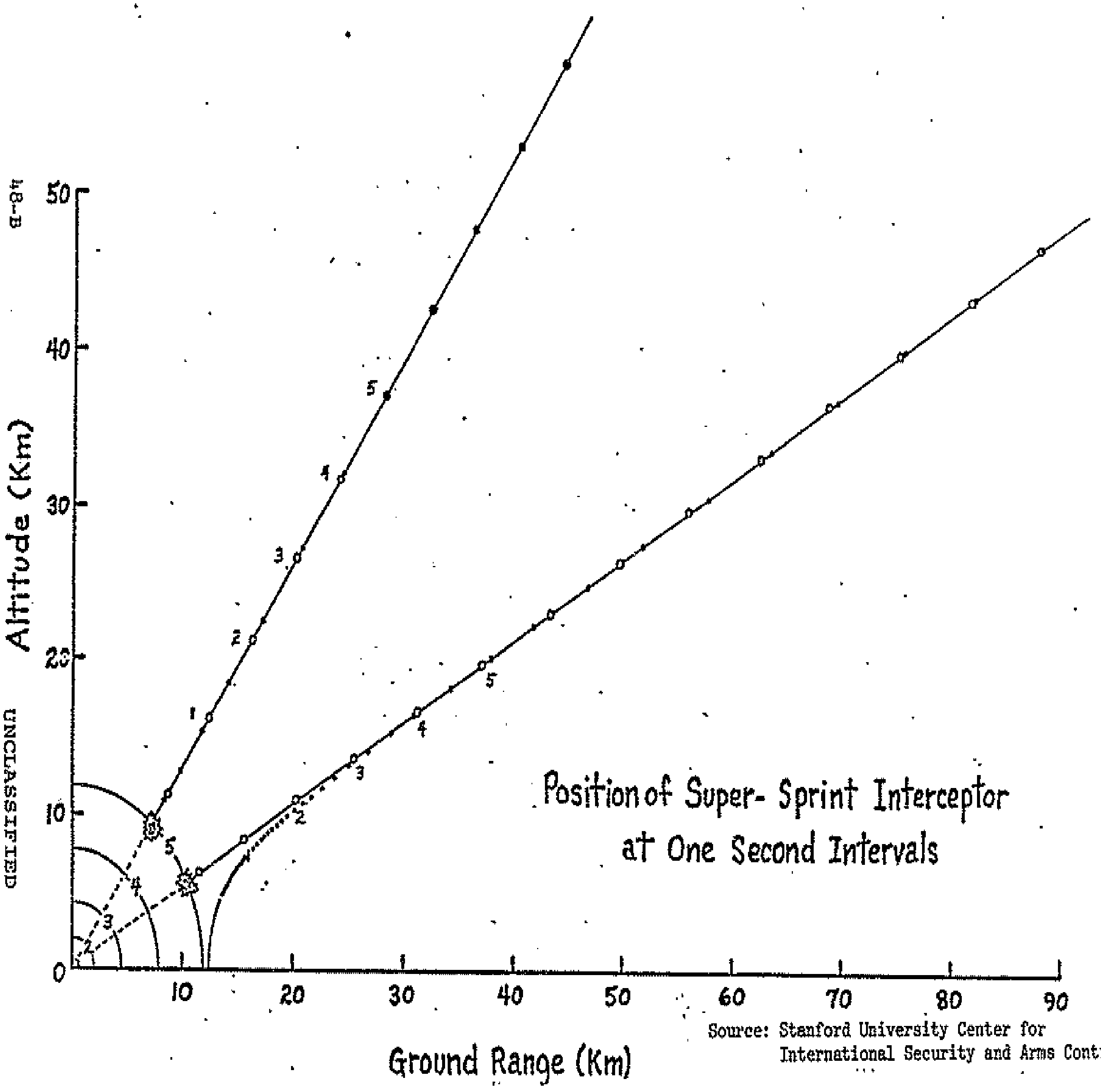
2000 nmi Range Lofted and Depressed Trajectories
Achievable with a 4000 nmi Range SLBM



Source: Stanford University Center for
International Security and
Arms Control

UNCLASSIFIED

UNCLASSIFIED



Source: Stanford University Center for International Security and Arms Control

Figure 33 UNCLASSIFIED

difference and relay the information to a HEDI interceptor.

A Soviet attack strategy that uses a mix of warheads and decoys on lofted SLBM trajectories thus might more easily overwhelm or exhaust HEDI defenses. Keep in mind the Soviet Union already operates SLBM systems that could launch decoys and warheads in lofted trajectories, which could threaten many major U.S. cities and installations.

In this section we have highlighted some of the technical hurdles SDIO faces in deploying just three operational systems in the near term -- the SBKKV, ERIS and HEDI. A number of highly effective ground- and space-based sensors also would have to be built in the near term, not to mention very sophisticated computers and battle management centers to coordinate, control and direct this force. In addition, a fairly extensive and low-cost transportation, support and logistics system would have to be built to deploy the battle hardware, such as space-based kinetic kill vehicles, and keep it running.

We are not suggesting that the technical hurdles involved with a near-term deployment of SBKKV, ERIS and HEDI, or the many other sensors and computers, cannot eventually be overcome. We are pointing out, however, that marching to a near-term system will not be a cakewalk -- not by any stretch of the imagination. SDI proponents tend to assume that a near-term deployment poses no major physics problems, only engineering problems that can be solved in short order. Indeed, a near-term option poses no major physics problems. But, as SDI's engineers are quick to point out, it is dangerous to assume that the engineering problems can be easily resolved.

When all is said and done, a near-term deployment by itself would be a massive endeavor for the Department of Defense and the defense industry. In the next section we will examine the implications of such an endeavor for the SDI research effort and U.S. national security.

VI. IMPLICATIONS OF A NEAR-TERM DEFENSE

After reviewing extensively the public statements that have been made by near-deployment advocates and the supporting documents they have produced, we have been struck by the absence of discussion of the implications of such a deployment. A good chess player always knows his second move. Yet little thought has been given to what our second move will be after a near-term deployment.

Near-term proponents tend to be victims of one-way thinking. Its advocates claim that near-term deployment will complicate Soviet strategic plans, thereby enhancing U.S. deterence. But how does a near-term deployment complicate U.S. strategic plans? A near-term deployment would place great strains on Soviet offensive development. But what strains do eventual Soviet countermeasures place on U.S. defenses? A near-term deployment would enable the U.S. defense industry and scientific community to focus on a definable goal. But how does striving to reach that near-term goal affect the pursuit of our far-term objectives?

The prevailing view among the scientists we interviewed in the national weapons labs was that not enough thought has gone into the implications for U.S. strategic defense research and U.S. national security if we proceed with near-term defenses. We don't know what our second move would be. We don't even know what the Soviets' first move would be.

What follows is a glimpse at some of the implications that were brought to our attention during our interviews and facilities visits.

A. Shifting Priorities

First of all, the movement toward a near-term deployment is creating turmoil in a research program that has already been plagued by radically shifting priorities and funding allocations the past three years. In 1986, we reported that SDI had undergone dramatic shifts in its priorities, largely as a result of a realization that many of the technologies would not produce militarily effective systems. Some project budgets were slashed, while other budgets were substantially increased. We noted in last year's report that while some shifting priorities in a relatively immature research program like SDI should be expected, wild fluctuations in priorities, if continued, could seriously harm the caliber of research. Indeed, in last year's Defense Subcommittee hearings, General Abrahamson assured Members that the program had settled down and we would no longer see such fluctuations.

In 1987, however, we are seeing once again the program's priorities shifting dramatically. Billion dollar space demonstrations that last year were being vigorously promoted on Capitol Hill as essential have been put on hold. Projects that last year were given high priority are now seeing their budgets frozen. Likewise, low-priority projects are now high-priority projects.

The question must be asked, how long can a research effort remain in this constant state of flux? SDI scientists say it cannot be too long. "What we need now is continuity and stability in this program," said one scientist. Furthermore, weapons lab scientists are acutely worried about their research being politicized as SDI proponents and opponents fight over the program's objectives. They fear that this politicization will increase as the program moves toward a near-term deployment. "It's having a terrible effect on our lab," said one scientist.

Incidentally, the lab scientists are not the only ones concerned about the turmoil that is occurring because of the near-term deployment push. SDI contractors are by no means unanimous in their support for the near-term deployment, despite the rush of defense dollars it would bring. Many contractors involved in far-term projects fear their funding will dwindle as resources become focused on the near term. Furthermore, we have heard from several sources that deep concerns over the near-term movement have been voiced privately even among some of General Abrahamson's program and project managers.

B. Effects on SDI Research

Last year, SDI scientists expressed deep concerns about the heavy concentration of SDI funds in early technology demonstration projects, the fear being that these projects would consume funds better used for basic research. That same fear was voiced by scientists we interviewed this year as it relates to near-term deployment. In a nutshell, SDI scientists worry that the near-term push will greatly distort the program's priorities and the ultimate victim will be SDI research itself.

In shifting to a near-term deployment, SDI in effect would be moving from a largely research program to predominantly an acquisitions program — that is, a program focused on actually erecting defenses rather researching which defenses are best. It is inevitable that "major acquisitions will crowd out basic R&D funding," according to one SDI scientist.

Another SDI scientist explained: "If you want to deploy an initial operational capability by 1995 you have to lock in the technology you have now ... If you go to engineering development now you can't expect to maintain a robust research program. There will be a big tendency to move ahead by eating your children."

Other scientists agreed. "When you go toward deploying a system," said one, "you put up an electronic field in front of research."

Not only is the far-term research inevitably cut back, the research in the immediate future becomes focused on resolving the problems at hand. "The near-term deployment will bias the research in that direction," said another SDI scientist, adding that the

scientific energy "will be devoted to resolving the critical issues involved with that deployment."

Obviously, these concerns apply to any military program that takes the step from research to development and deployment. The question for Congress becomes, is this step premature for SDI at this point?

Another question raised in the weapons labs is whether, in fact, the scientific and engineering communities plus the defense contractors can work fast enough to achieve an early deployment in the 1994-95 timeframe. "There's a serious question of whether we can institutionally move to a 1994 initial operating capability," said one SDI scientist. "Unless there's a national emergency, it seems doubtful ... We've built in this institutional slowness into military research. The administrative requirements alone add an extra year to any major research project." We might add that none of the SDI scientists we interviewed described any national emergency impending or on the horizon that would necessitate a crash program to deploy in the near term.

Finally, the SDI scientists were deeply worried that a premature deployment of strategic defenses, if it resulted in huge expenditures and very little was accomplished, might poison the political well for SDI research in general. "The first victim out of all this would be the research getting whipsawed," warned one scientist. "It would be a tragedy if the near-term deployment debate resulted in killing SDI research or truncating it."

C. <u>Cost Effectiveness</u>

We were told that cost estimates for a deployed strategic defense system have been generated among SDI contractors but these estimates have not been released because SDIO could not validate them. The bottom line, however, is that if top DoD officials can come before Congress and testify with dead certainty that comprehensive strategic defenses are feasible and can be deployed within a given timeframe, they should be just as forthcoming about estimating what it will cost the taxpayer.

This should be the case, even more so, if a near-term deployment is pursued. It seems inconceivable to us that a decision to proceed with a near-term deployment would be made without any reliable cost estimates. Indeed, with the growth in defense spending likely to be slowed over the next seven years and with a procurement bow wave emerging over that period, it would be dangerous not to have prior to a deployment decision cost projections for a near-term deployment in the 1994-95 period. Validated cost estimates should be distinguished from cost goals, the latter of which SDI has proffered frequently.

Not only should the cost of a near-term system be determined ahead of time, its cost-effectiveness also should be established. In 1985 Congress passed and the President signed into permanent law a

provision barring any SDI deployment unless it was certified to be cost-effective at the margin and survivable against Soviet countermeasures.

Some argue that a near-term deployment might not be cost effective initially, but would become cost effective when later expanded to a far-term, comprehensive area defense. That would not satisfy the requirements of the 1985 law, which specifically says that a deployment cannot be made "in whole or in part" unless it meets the cost-effectiveness and survivability criteria.

No one we interviewed was prepared to say that a near-term deployment, based on the current body of evidence, would be cost-effective. It is simply too early to tell. It would appear to us that a near-term deployment decision entails considerable risk without a clear certainty of the deployment's cost-effectiveness.

D. Uncertainty over the Second Move

As noted before, SDI scientists realize full well that a near-term deployment will consume a tremendous amount of resources. Even if the most optimistic cost projections are assumed, the deployment would still involve a major expenditure by the federal governemt. The big question becomes, What do we do after we deploy? Or, what is the second move?

To answer the question, first consider three facts:

1. If we deploy in the near-term, the Soviets will respond with proliferation of their offensive force, their own defense system, or with countermeasures to overcome U.S. defenses, or all of the above. The only disagreement among SDI scientists is how fast the Soviets would respond and what they would respond with.

2. The Soviet response will mean the United States will have to build new defensive systems for the boost phase such as directed energy weapons that will be more capable and survivable than the kinetic energy weapons systems that would be deployed in the near term. At this point, SDI scientists do not know whether those directed energy systems actually can be built so they can operate in a battle environment. Even the physics of several of these systems is yet to be understood. Different components and small-scale models of some systems have been produced and tested, but not the entire system. The SDI research program is to answer whether these far-off systems will actually work.

3. The Soviet response also will result in the near-term deployment eventually being swamped with warheads and decoys. That is why SDI is pursuing exotic technologies that might eventually perform midcourse discrimination. But do we know at this point that we can solve the midcourse discrimination problem with a practical and affordable system? "The answer is, no," said one lab scientists with extensive experience in SDI systems analysis. At this point "it becomes a matter of faith and experience that we will solve the

discrimination problem."

As has been pointed out previously, a near-term deployment of space-based kinetic kill vehicles will have a short-lived capability in space as the Soviets develop their responsive threat. SDI scientists disagree on which response the Soviets would pursue or in what order they would pursue: fast-burn boosters, decoys, ground-based anti-satellite interceptors, nuclear weapons detonations in space, Soviet SBKKVs attacking our SBKKVs to punch a hole in the defense.

What the SDI scientists do agree on is that whatever the responses the effectiveness of space-based kinetic kill vehicles will degrade in the face of it. The only question is how soon.

Figures 34 and 35 show how this degradation would occur and how enabling, or bridge, technologies would be deployed to fill the gap. A fleet of SBKKVs deployed in would significantly degrade in capability within as the Soviet responsive threat increased. The system could maintain a robust capability only if enabling technologies, such as free electron lasers and neutral particle beam discriminators, are phased in. The issue on the minds of many SDI scientists is whether the enabling technologies will be available to be phased in as the capability of the near-term deployment decreases.

"The real question is not can you deploy in 10 years," said one SDI scientist. "The real question is, is there a gap after that deployment? Do you have the bridge technologies, like midcourse discrimination, which you're going to need to have in the future.

"The problem you have with an early deployment that is done at the expense of everything else is that you end up with a tremendous initial system that is enormous — but it quickly degrades."

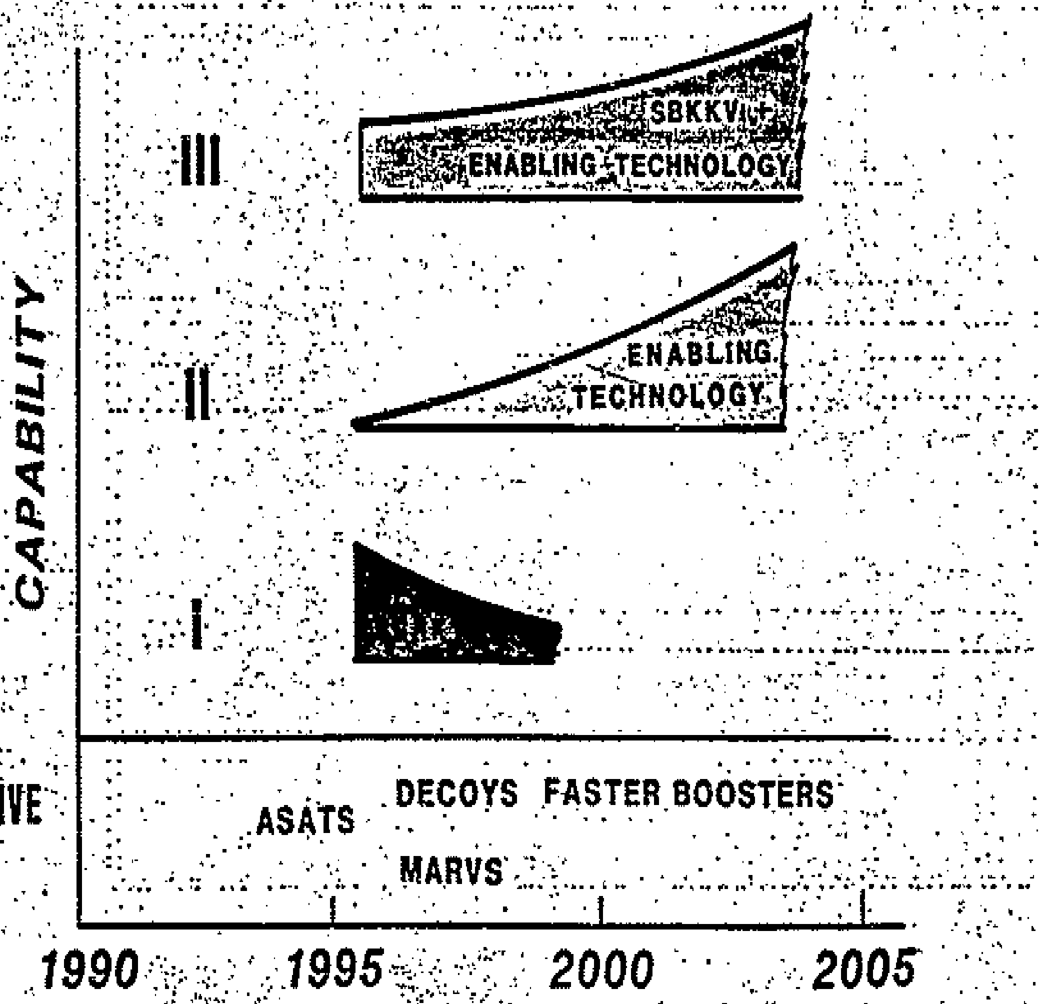
The SDI scientist we interviewed were clearly worried that the enabling technologies would not be there when needed. A near-term deployment would consume considerable resources and much research talent, they fear. After all the problems of a near-term deployment are solved, would there be enough money to fund adequately the vital far-term technologies?

"If you don't have the follow-on enabling technologies," said one SDI scientist, "you will erode the capability of the space-based kinetic kill vehicles — and you may well end up with a more destabilizing situation than before."

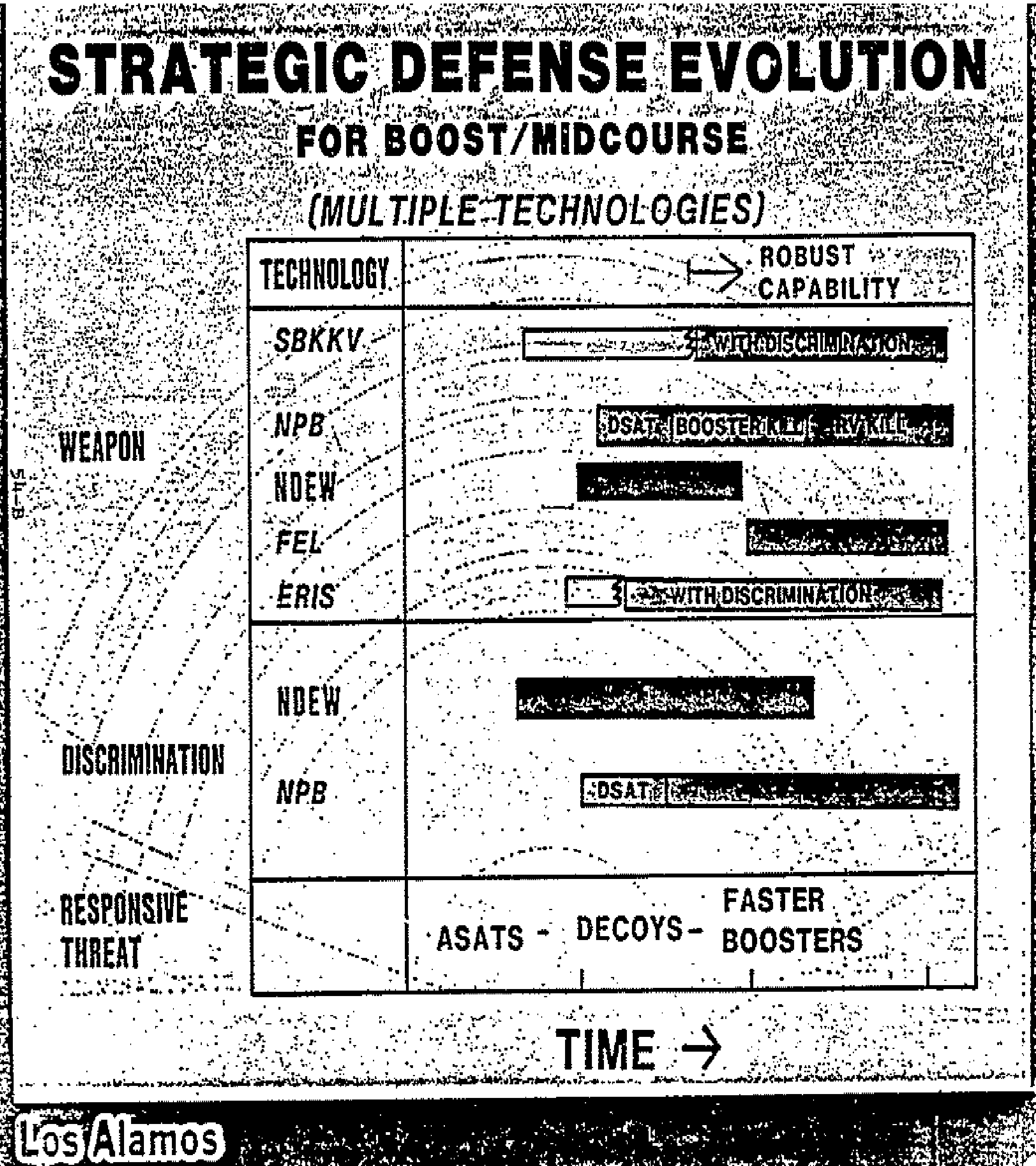
Also, if the Soviets speed up their response to a near-term deployment and the U.S. does not follow up, "you're in a world of hurt," said another scientist.

We must note that there is already evidence, based on the FY87 and FY88 funding levels, that advanced or far-term technology research is being shortchanged to meet near-term objectives. We have pointed out in other sections of this report instances where this

DEW PROGRAMS CAN SUPPORT AND INCREASE CAPABILITY OF NEAR TERM SDI ARCHITECTURE



Los Alamos



54-B

UNCLASSIFIED

Figure 35

UNCLASSIFIED

shortchanging is occurring.

Two other questions must be asked? Will there be a national commitment to pursue the enabling technologies that will take up where the near-term defenses leave off? Just to deploy a near-term defense will require a major increase in funding for the SDI program. If we are to pursue the enabling technologies on top of that so we are confident they are available to come on line at the right time, even larger funding increases will be required for that advanced research. Last year, Congress established what many believe was a cap for the program of somewhere in the $3-4 billion range annually. Regardless of whether there is the national will to launch a crash program to begin near-term defenses, is there the national will to spend even more money to make sure those defenses survive in the outyears?

Secondly, at this time SDIO does not know for certain whether the enabling technologies actually can produce a follow-on defense. Remember that SDI's goal, given a crash effort, was to research exotic laser and beam technologies sufficiently to permit a full-scale engineering development decision in the early 1990's. Committing to an early deployment of the conventional mature technologies prior to having the knowledge to make a development decision on the exotic technologies would be risky indeed.

Should we leap into a near-term defense without knowing whether we can really make the second move? Should we deploy early when we are not certain the technology will be available for us to be effective later? As will be pointed out shortly, a near-term deployment will result in early U.S. abrogation of the 1972 ABM Treaty and an intense offensive-defensive arms race. Should we make a decision now to start that race, even though we are not certain whether survivable and effective second-generation defenses can be deployed?

E. <u>Space Transportation</u>

Moving to a near-term SDI deployment means a radical shift in U.S. plans for future space transportation.

As has been noted previously in this report, the Defense Department is seeking to accelerate development of a heavy-lift launch vehicle so it can be designed, built, tested and be ready for operation in apparently only five years. This early HLLV would lift material into space at a cost of $1,000 per pound by 1992-93. SDI's goal, however, is to ultimately have a HLLV that can lift into space for $200-$400 per pound by the end of the century.

Pressing ahead with an HLLV on this type of schedule brings with it several disturbing consequences. First, SDI's near-term deployment must rely on a transportation system that cannot meet the often-quoted

SDI goal of a ten-fold reduction in operating costs to \$200-\$400 per pound. At best, and this is only a goal, the near-term heavy-lift rocket can be expected to achieve a three-fold reduction in operating costs to \$1,000 per pound. This puts the near-term deployment at a severe cost disadvantage from the beginning.

Second, we question what additional risk is imposed on the heavy-lift launch vehicle program by having to meet this near-term deadline. In March 5, 1987, testimony before the Senate Subcommittee on Science, Technology and Space, Dale Meyers, Deputy Administrator of NASA, warned that neither NASA nor the Air Force knows what HLLV technologies slated for the late 1990's can be pulled back to the early 1990's. Reliability, he said, is the issue. Without it, SDI risks losing very expensive cargoes with HLLV's that fail. By way of example, the last Titan missile that blew up reportedly had a payload worth more than \$800 million. Indeed, it would be a tragedy if in its rush to a near-term HLLV, America ends up with an unreliable space transportation system.

Finally, the rush to build an interim heavy-lift launch vehicle may adversely affect NASA's future civilian space program. In the past, America's giant space rockets such as Saturn V were developed by NASA as the lead agency. NASA also apparently has the expertise and facilities to be the lead agency to develop the HLLV. However, "the requirements for the HLLV are dominated by the DoD," according to Air Force Secretary Edward Aldrich. As it now stands, DoD will lead the development of both the National Aerospace Plane and the HLLV. Certainly, a rush to an interim HLLV will mean NASA with its limited resources will have to defer to the Defense Department to lead the HLLV effort. Can NASA retain good people if it becomes DoD's weak sister in space transportation? More likely, NASA would have to commit resources to the interim HLLV effort if there is any hope of it succeeding. NASA's budget, however, is already stretched to the limit with the upgraded shuttle, a future space station, and continued interplanetary unmanned exploration. Can it be stretched even further to accommodate the interim HLLV requirement?

F. Arm Control Implications

As noted previously in this report, the push for an early SDI deployment may be motivated by either a desire to cement the program politically, provide early operational training for BMD forces, force an early decision on the so-called "broad" interpretation of the ABM Treaty, or to correct what SDI proponents perceive to be a dangerous imbalance in U.S.-Soviet forces. Whatever the motivation, the result of an announced commitment by the President to proceed with a near-term deployment would be clear: early abrogation of or U.S. withdrawal from the 1972 ABM Treaty.

The only kind of early deployment that might avoid abandonment of the Treaty would be the placement of 100 ERIS-type interceptor missiles at Grand Forks, North Dakota, per Lockheed's proposal. Such a deployment would have little military value, however. In addition, the Administration, and Secretary Weinberger in particular, have

indicated they are not interested in such a limited role for SDI using essentially off-the-shelf technology, as the Lockheed proposal would involve.

An early deployment, Mr. Weinberger has insisted, must be integral to a more comprehensive SDI deployment. If that is the case, such a deployment, say in the 1994-95 timeframe, would kill the ABM Treaty. In fact, the Treaty would likely be a dead letter well before the deployment began.

To picture how this quick erosion of the ABM Treaty would occur, consider first that SDI last year had planned for its research to be in compliance with the strict interpretation of the Treaty at least until the early 1990's. For example, the 1985 SDI Report to Congress stated specifically that "research necessary to support a decision on the potential utility of the SDI technology can be conducted in accordance" with the ABM Treaty. The 1986 report gave the same assurance. Furthermore, in our briefings last year and this year, SDI scientists, engineers and program managers said the research they needed to conduct through the early 1990's could be conducted under the strict interpretation of the Treaty. Of course, SDI tests could be devised that violate the Treaty or that fall under the broad interpretation; but those tests would not be necessary to carry out the SDI program objectives.

If the President decides to proceed toward an early deployment in the 1994-95 timeframe, however, the ABM Treaty would be on a slippery slope fairly quickly. To meet a 1994-95 initial operating capability, first a formal decision to deploy would have to be made probably within a year. Next, a full-scale engineering development decision (FSED) on the systems to be deployed would have to be made in the 1990-91 timeframe. Then, operating on what one SDI official admitted would be "a very heroic schedule," three to five years would be spent racing from the FSED to production to deployment.

When does the ABM Treaty, as it now stands, become extinct under this scenario? Technically perhaps no later than 1990-91 when the full-scale engineering development decision was made. The date might be earlier, but we do not know at this point. On the other hand, it is unclear whether an early deployment would even necessitate tests, such as those of space-based kinetic kill vehicles, which would violate the Treaty prior to the 1990-91 FSED.

Most likely, it would not matter exactly when in this timeframe the violation actually occurred. It would be naive to assume that the Soviet Union would wait until the United States formally exercised the 6-month notice provision for withdrawal from the Treaty before it responded. If we announced our intention to deploy and in effect break out of the Treaty by a certain date, the Soviets would probably launch their countermeasures in anticipation of that date and would disregard any restrictions in the Treaty. Once the race started, we cannot assume that the Soviets would wait a lap before running.

The early destruction of the ABM Treaty appears to be of little concern to proponents of near-term deployment. Congress, however, may

want to consider the following questions:

- How difficult would it be to patch back together the Treaty if at a later date the U.S. determined the near-term deployment was a bad idea, or the follow-on technologies to reverse system degradation did not prove feasible?

- What kind of deep political divisions would it cause between the United States and its allies in Europe and the Far East;

- What effect would it have on all arms control negotiations between the United States and the Soviet Union?

- Of a more immediate concern, what effect would just the immediate near-term deployment decision have on the breakthrough U.S. and Soviet negotiators have achieved in the INF talks? Would a deployment decision re-link SDI to INF?